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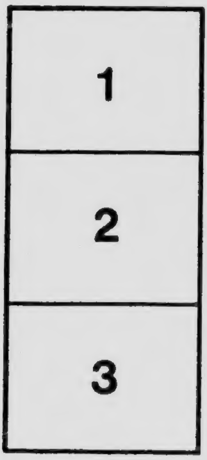

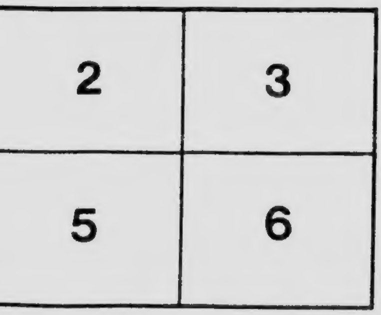

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DOMINION WATER POWER BRANCH
DEPARTMENT OF THE INTERIOR
OTTAWA, CANADA

WATER RESOURCES PAPER No. 11.

PASQUIA
RECLAMATION PROJECT

BY

T. H. DUNN, C.E., O.L.S.

Prepared under the direction of the Superintendent of Water Power

No. 12B, Part VIII, Annual Report 1914

OTTAWA
GOVERNMENT PRINTING BUREAU
1915

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DOMINION WATER POWER BRANCH
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WATER RESOURCES PAPER No. 11

REPORT

ON

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CONTENTS.

	Page.
Itinerary	5
Object of Investigation	6
The Pasquia District	7
Discharge of Saskatchewan River	7
Rainfall and Runoff	9
Temperature	11
Outlet	11
Lake Winnipegosis	12
Elevations	13
Proposed Improvement	14
Estimates	16
Low Level Channel	17
High Level Channel	17
Area to be Reclaimed	17
Cedar Lake	18
Time for Completion	19
Navigation	19
Power	20
Summary	20
Conclusion	21

TABLES.

Saskatchewan River near The Pas—Discharge Measurements for 1912-13	22
Saskatchewan River near The Pas—Approximate Daily Gauge Height and Discharge, 1912.	23
Saskatchewan River near The Pas—Daily Gauge Height and Discharge, 1913	24
Saskatchewan River near Grand Rapids—Discharge Measurements for 1909-10-12-13	25
Saskatchewan River near head of Grand Rapids—Daily Gauge Height and Discharge for 1912	26
Saskatchewan River near head of Grand Rapids—Daily Gauge Height and Discharge for 1913	27
Precipitation, Pas, Manitoba, 1910-13	28
Precipitation, Swan River, 1909-12	28
Precipitation, Melfort, Saskatchewan, 1909-13	28
Precipitation, Cumberland, Saskatchewan, 1911	29
Precipitation, Lost River, Saskatchewan, 1911-13	29
Temperature, Pas, Manitoba, 1910	29
Temperatude, Pas, Manitoba, 1911-14	30
Temperature and Barometric Readings, Eastern Pasquia District, 1912	31
Temperature, Pasquia District, 1913	33
Runoff, 1912-13	35

ILLUSTRATIONS.

The Narrows	6
Summerberry River, five miles from head	10
Big Lake at low water	14
Saskatchewan River, shore line near Frying Pan Rapids	19

PLATES.

No. 36—Map of part of Province of Manitoba...... ....Inside back cover.
No. 37—Diagram of mean monthly discharge of Saskatchewan River at Pas, Manitoba...... .... " "
No. 38—Diagram of mean monthly discharge of Saskatchewan River at Grand Rapids, Manitoba...... .... " "
No. 39—Diagram of combined discharge curve of high and low channels, Saskatchewan River, Cedar Lake to Cross Lake...... ...... " "
No. 40—Cedar Lake to Cross Lake. Key Map...... .... " "
No. 41 " " Topographical Sheet No. 1...... .... " "
No. 42 " " " " No. 2...... .... " "
No. 43 " " " " No. 3...... .... " "
No. 44 " " " " No. 4...... .... " "
No. 45 " " " " No. 5...... .... " "
No. 46 " " " " No. 6...... .... " "
No. 47 " " " " No. 7...... .... " "
No. 48 " " " " No. 8...... .... " "
No. 49 " " " " No. 9...... .... " "
No. 50 " Frying Pan " " No. 1...... .... " "
No. 51 " " " " No. 2...... .... " "
No. 52 " " " " No. 3...... .... " "
No. 53 " " " " No. 4...... .... " "
No. 54 " " " " No. 5...... .... " "
No. 55 " " " " No. 6...... .... " "
No. 56 " " " " No. 7...... .... " "
No. 57 " Cross Lake. Profile of proposed canals.... .... " "

REPORT ON PASQUIA RECLAMATION PROJECT.

OTTAWA, June 11, 1914.

J. B. CHALLIES, Esq.,
Superintendent, Dominion Water Power Branch,
Ottawa.

SIR,—Following your instructions of May 7, 1913, I continued my examination of that portion of the Pasquia reclamation district tributary to the Saskatchewan river, and lying between The Pas and Grand Rapids in the province of Manitoba.

Work was commenced at Cross lake on June 3, which was the earliest date on which this lake could be reached, by causes owing to the presence of ice in Cedar lake. Camp was maintained at Cross lake until July 18, during which time a topographical survey was made of a considerable portion of the peninsula between the Saskatchewan river and Cross lake, together with a traverse of the shore line and soundings of the waters contiguous thereto. On completion of this work, camp was moved about five miles upstream to The Narrows, which is at the eastern extremity of Cedar lake. From this point the traverse and profile of the river was completed, and the topography of the various islands in the river and shores of Cedar lake in the vicinity of The Narrows taken. A very great number of soundings were taken in the river and in the eastern end of Cedar lake.

During June and part of July, the swamp in the interior of the Cross lake peninsula remained frozen to such an extent that no examination of the underlying materials could be made to a greater depth than 1 or 2 feet. For this reason a party had to be sent back to Cross lake to make tests later in the season.

In making soundings at Rabbit Point no shoal of importance was discovered. Nevertheless, it seems quite certain that a shoal exists slightly to the eastward of the point. Soundings were taken directly off, and also to the westward of the point, but none were taken to the eastward. The failure to locate and survey this shoal is the result of a misunderstanding of my instructions, and for the same reason no soundings were taken off Duncan island, which is located at the west end of Cedar lake near the entrance of the Saskatchewan river.

A line of levels was run across High Portage, and a very short series of simultaneous gauge-readings taken in both lakes. The survey work was concluded by a traverse of the Swallow creek branch of the Saskatchewan river, a traverse with profile and soundings of the boat channel of the Saskatchewan as far as Brown Rock and a traverse with soundings from the Brown Rock to The Fryingpan.

The Brown Rock is about 4 miles upstream from the Hudson's Bay Company's post at Chemawawin, and the Fryingpan is about 12½ miles up from the same point measured along the boat channel. There is an outcrop of rock at both these points as well as at Chemawawin, and they are the only places in this vicinity high enough to make camp on during high water.

The party started to break up on September 26 and by October 6 was so reduced as to make it impossible to continue the survey work; consequently the remainder was organized into a party for the securing of soil samples, of which, unfortunately, we have been unable to procure an analysis.

I regret that the work on the river could not be completed as far as The Pas, as a profile of this section from Cedar lake to The Pas would greatly assist in a solution of the reclamation problem. It is not absolutely essential at this stage, however, but the absence of the information leaves the question of the necessity for improvement of this part of the river somewhat obscure.

OBJECT OF THE INVESTIGATION.

On the 26th day of January, 1912, an application was made on behalf of the Dominion Land and Drainage Company for "authority to drain and reclaim all the ungranted lands on both sides of the Saskatchewan River and all the branches thereof, including the lands surrounding Cedar and Cross lakes, whether submerged or occasionally submerged, from The Pas to Grand Rapids."

Pasquia Reclamation Project. The Narrows.

The application further states that "the object of the applicants is to construct the necessary works to enable the said lands to be used for farming purposes."

On January 31, 1912, another application was made on behalf of the same company for "authority to drain and reclaim all the ungranted lands within the watersheds of Big Lake river and Overflowing river."

The application states further that "the object of the applicants is to construct the necessary works to enable the said lands to be used for farming purposes," and "it is the intention of my clients to construct one general system of drainage and reclamation works covering all the lands applied for, both in this letter and in my previous letter of 26th of January last."

In view of these applications, I was instructed to examine the district and to inquire into the conditions as to drainage, etc. My investigations were conducted for the purpose mainly of determining:—

(1) The possibility of relieving from flooding the lands cited in the applications of the Dominion Land and Drainage Company.

(2) The cost of constructing the works necessary to afford such relief.

(3) The economic advantages to be derived from the construction of such works.

In addition to these considerations I also had regard to the effect which the construction of the reclamation works might have on navigation and the development of the power at Grand Rapids, but these may be said to be included in the third item cited above.

The Pasquia District.

The name "Pasquia," as applied to this district by the late Mr. Ogilvie, was intended to include the entire area affected, in a greater or less degree, by the flooding of the lower Saskatchewan river. This he called the "Pasquia Reclamation District," and it has since been known by that name, although in my report on my 1912 work I applied the same name to the eastern half of the district. The district is about 150 miles long by 70 miles wide, and extends from near the head of the Sipanok channel on the west to Cross lake on the east. It is divided near the centre by a ridge of higher ground on which is situated the town of Le Pas, commonly called The Pas, the only town in the district outside of the Hudson's Bay trading posts. Besides the numerous channels of the Saskatchewan, the only rivers of importance are the Carrot and the Pasquia, both of which are in the western half of the district. In addition to the many small lakes and ponds, there are numerous lakes of considerable size such as Cumberland, Saskeram, Reeder and Pas lakes in the western half, and Atikameg or Clearwater, Cormorant, Moose, Cedar, and Big lakes in the eastern half.

West of the Sipanok channel the Saskatchewan flows over sharp grades and follows strictly the true channel of the river but, nearing the Sipanok, the grade flattens and the water divides, part going through the Sipanok in high water, a much larger part going northerly to Cumberland lake, and the balance following the old river-bed. The water all re-unites at The Pas to be again divided and finally re-united at Cedar lake. On this last stretch, from The Pas to Cedar lake, the principal channels are the Saskatchewan proper and the Summerberry, the latter of which receives the drainage from Clearwater, Cormorant and Moose lakes through Moose creek. In the vicinity of Cedar lake, and for some distance west, there is a perfect maze of channels, but all converge in Cedar lake.

It was reported to me that a very considerable volume of water is deflected from its proper outlet in the Churchill river to an outlet in the Saskatchewan river by way of Cumberland lake. Should this be found to be the case, it might be regulated at or near the point of overflow with considerable advantage to drainage in the Pasquia district.

The whole district comprises an area of about 10,000 square miles, but in this report we are concerned with only the eastern half. The total area of the eastern portion of the district draining to the Saskatchewan river and Cedar lake is approximately 5,230 square miles, but this includes a considerable area to the north of Cormorant lake which is well outside the reclamation district.

Discharge of Saskatchewan River.

Previous to the year 1913, but few measurements of the discharge of the lower Saskatchewan river had ever been made. In the year 1909, Mr. Forward, C.E., acting for the Public Works Department, made a measurement by means of surface floats at Grand Rapids, and another measurement at The Pas in the same year. In 1910 Mr. Wm. Ogilvie, D.L.S., made two meterings at Grand Rapids for the Water Power Branch. In 1911 the Department of Public Works secured two meterings at The Pas. Two meterings at The Pas and three at Grand Rapids were secured by the Water Power Branch in 1912. These three measurements made at Grand Rapids were taken at the same station as the two measurements made by Mr. Ogilvie in 1910, and the information afforded by this series made it possible to construct an approximate discharge curve for this station. No systematic series of gaugings or meterings were undertaken, however, until the year 1913, when the Water Power Branch established a new station at The Pas and procured twenty-seven meterings. Five meterings were also taken at the Grand Rapids station in 1913.

The station at Grand Rapids is near the eastern limit of the Pasquia district, while the station at The Pas is near the centre. It is much to be regretted that no metering station has been established at the western limit near the Sipanok channel, although this is not of so much importance in a study of the eastern portion of the district as of the western portion.

As previously stated, the ridge at The Pas divides the Pasquia district into two sections which are more or less distinct, and must be treated separately, except as to the final outlet which is common to both. Where the river passes through the ridge at The Pas, the cross section is somewhat contracted, and this regulates the discharge at this point by holding back a large percentage of the flood waters in storage between The Pas and the Sipanok channel. However, as long as the storage west of The Pas is not reduced, the discharge at The Pas, together with the run-off from the portion of the Pasquia district east of The Pas, will give a close approximation of the flow that will have to be provided for in any scheme of reclamation for the eastern district.

The condition of flooding on the lower Saskatchewan follows the melting of the snow in the Rocky Mountains, and hence varies in extent and duration according to the snowfall and temperature.

The rainfall, of course, is an important factor, and there are other influences which affect the result, but no possible combination of circumstances could cause a flood in the absence of snow in the mountains, or prevent a flood when there is a condition of plenty of snow followed by mild weather. A late cool spring invariably produces a flood of short duration with very high water in the summer, generally in the months of July and August; while an early spring produces moderately high water throughout both spring and summer with very low water in the fall. This is the case with all snow-fed streams subject to flooding.

In 1912 the spring was late and cold, and the water in the river was consequently low until the month of July, when the warm summer weather caused a steady rise until August 6. On this date the peak of the flood was reached, and lasted for three days when it fell somewhat, but remained comparatively high until the end of September, when it fell steadily at about the same rate that it rose in July. A slight rise early in November made unusually high water for that season of the year.

In 1913, the conditions were entirely different. The spring was early and warm, and the water rose in the latter part of April and first part of May almost to the maximum height for the season. It was only moderately high throughout the season, and fell uniformly from September 7 to a very low level in the following winter.

While the study of the flow in the river has not extended over a sufficient time to justify any very definite conclusions, an examination of the discharge data would seem to indicate: (1) Extremely high floods of short duration in short hot seasons; (2) Moderate floods in long mild seasons; (3) A return to approximately the same extremely low elevation in the month of February of each year.

The maximum discharge in a high-water year lasts only for two or three days and is not, therefore, so important a factor as the mean of the 15 days preceding and 15 days following the maximum. It is unnecessary to consider moderate floods even if of long duration.

The extremely low elevation which prevails every winter, although detrimental to power development is, in the absence of summer storage, of great value in the scheme of reclamation, as it will permit Cedar lake to be drained to an elevation but little above the elevation of Cross lake, without the construction of a very wide low level canal.

The flood discharge of the Saskatchewan river at The Pas is, in ordinary high water years about 60,000 to 75,000 cubic-feet per second while the lowest winter flow yet recorded was but little over 4,000 second-feet. The winter discharge at The Pas may be taken at 5,000 second-feet. This makes it possible to reduce the elevation of Cedar lake to such a point, that a channel of moderate width will be sufficient to prevent it rising high enough in summer to cause flooding of the reclaimed lands.

During flood periods, the Saskatchewan river flows in part into Moose lake, and it might be at first supposed that the storage in Moose lake would keep up the winter flow at The Narrows; but it will be readily seen that the lowering of Cedar lake will stop the flow which now passes from the Saskatchewan river into Moose lake during high water, and only the run-off from the Moose lake basin will come from that quarter.

Should there be any considerable discharge from Cormorant lake to Moose lake by way of Frog creek, and thence to the Saskatchewan river by way of Moose creek, it could be regulated at the head of Moose creek; but Moose lake could not be held very high, as it would probably affect the drainage of a portion of the area which it is sought to reclaim and, again, the lake would be likely to overflow through Sturgeon river to the north arm of Cedar lake. Sturgeon river could not be readily dammed, as it rises in a muskeg which extends to Moose lake. The amount of possible regulation at Moose lake is, therefore, somewhat limited.

The greatest discharge at The Pas during the year 1912, the first year in which there is a complete record of gauge readings, was in the month of August, when the average for the month was 67,732 cubic feet per second. This was considered a high-water year, and was caused mainly by a late cold spring, which prevented any material run-off during the early part of the season, thus concentrating the flow in the warmer part of the summer. This condition was somewhat supplemented by heavy rains during July, a part of August and September. In the year 1913 the greatest flow was in July, when the average for the month was 60,402 second-feet.

A monthly average of 70,000 second-feet discharge at The Pas may be considered as very unusual, and a greater discharge than this is so rare as to be negligible for the purposes of this report.

Rainfall and Run-off.

The first report of the Meteorological station at The Pas appeared in the issue of the monthly weather review of June, 1910, since which time monthly reports have appeared, but with considerable irregularity.

From June to December, 1910, the seven months reported, the rainfall amounted to 12.75 inches. In ten months of 1911, omitting January and June, the total precipitation amounted to 16.23 inches, while in eleven months of 1912, omitting April, it was 16.09 inches. There is no report for the months of April or June in 1913, which leaves the data very incomplete for the year, as the rainfall during these two months is usually comparatively heavy. The greatest precipitation recorded at The Pas, according to the report of the Weather Bureau, was for the month of July, 1911, and amounted to 4·67 inches for the month. In the month of July, 1912, the rainfall was 4·39 inches, and in September of the same year it was 3·59 inches, which is a record for that month.

There are no other stations in the Pasquia district reporting rainfall. Some reports were made from Cumberland House in 1911, but these were discontinued with the November report of that year. The reports from Melfort, Swan river and Lost river are attached to this report; all these are in the Saskatchewan basin excepting Swan river.

The area of the Saskatchewan drainage basin lying between the Pas and the Narrows is approximately 5,230 square miles. Over this large area there are not likely to be any general storms of great violence. Very heavy storms will probably occur from time to time over some part of the drainage basin, but never over the whole area at the same time. While it will be imperative to provide for such storms, in designing the interior drainage, they will have but little effect on the outlet. If an outlet be provided with sufficient capacity to carry off the maximum monthly rainfall, no flooding will result from occasional heavy storms over small areas.

The annual precipitation in this district is light, the average amounting to about 17 or 18 inches. There is a record, however, of 6·04 inches having fallen at Melfort in July, 1912, although no such fall has ever been reported at The Pas. Assuming that 6 inches of rain may fall over the whole area in 30 days, and that the run-off during the growing season of June, July and August will not exceed 30 per cent of the rainfall, we have 1·8 inches run-off from the whole area in 30 days. This is equivalent to ·00252 cubic-feet per second per acre, or 1·6128 cubic feet per second per square mile.

Pasquia Reclamation Project. Summerberry River, five miles from head.

The total discharge from 5200 square miles at this rate would be 8,386 cubic feet per second. This run-off, taken in conjunction with the discharge at The Pas, gives an approximation of the discharge at the Narrows under reclamation conditions.

In the year 1901, there was a very unusual flood on the lower Saskatchewan, when almost the whole of the Pasquia district was covered with water. It has been estimated that the discharge at The Pas reached considerably over 100,000 second-feet, and possibly as much as 150,000 second-feet. The peculiar combination of circumstances which caused this enormous flood may never occur again, but in ordinary high-water years there may be as much as 75,000 second-feet passing The Pas for a few days at the peak of the flood. As previously stated, a monthly average of 70,000 second-feet is excessive, and this, in conjunction with the run-off of 8,386 second-feet, would give a discharge at the Narrows of 78,386 cubic feet per second.

An examination of the run-off data submitted herewith shows the maximum run-off to take place in the Little Saskatchewan in April, and amounts to 1·55 cubic feet per second per square mile. This is over the comparatively small area of 1,250 square miles, and is the maximum recorded in Manitoba by the Water Power Branch. In view of this, and having regard to the large area and flat grades of the eastern Pasquia district, it seems unlikely that the run-off from the district will ever exceed my estimate of 1·61 cubic feet per second per square mile.

Temperature.

Maximum and minimum temperatures were observed at Cross lake and Cedar lake in 1912 during the period the party was on the ground, and a practically continuous record was obtained during the season 1913 from June 8 to September 28.

The following is a summary of the observations for 1912 and 1913:—

		Average Maximum.	Average Minimum.
1912		°	°
August	30 days	[illegible]3·5	49·6
September	30 "	62·2	40·9
October	25 "	48.5	32.3
1913.		°	°
June	22 "	71·6	51·6
July	31 "	71·5	53·7
August	31 "	71·4	52·2
September	26 "	61·4	45·3

In 1912, rain fell on nine days in August, and rain or snow fell on nineteen days in September, and the weather was almost uniformly bad during the continuance of the party in the field. The season of 1913 was a great contrast to that of 1912, the weather being very fine, and all that could be desired for field work during the greater part of the season.

Outlet.

The outlet for the waters of the Saskatchewan river is at present, and probably always will be, in lake Winnipeg, which is reached after passing a series of rapids known as Flying Post, Demi-Charge, Cross Lake, Red Rock, and Grand Rapids, with a total fall of 119½ feet in 24 miles, or an average of about 5 feet per mile. This fall is not, however, distributed with any uniformity as the following table shows:—

	Feet.
Flying Post rapid, fall is	3·71
Demi-Charge rapid, fall is	5·91
Cross Lake rapid, fall is	4.00
Red Rock rapid, fall is	12.20
Grand Rapids rapid, fall is	74·67
Total	100.49

The balance of the fall is in the stretches of swift water between these rapids.

The western extremity of this rocky pitch is at Cedar lake ere the waters are dammed back by a rock barrier causing the rapid at Flying P while a few miles farther down is another rock outcrop causing the Demi-Charge rapid just at the entrance to Cross lake. The distance between Cedar and Cross lakes is about 6 miles, and the fall is 15·15 feet.

No substantial relief from flooding can be obtained except by the lowering of Cedar lake, which can only be effected by the improvement of the river between its eastern extremity and Cross lake. It was hoped that a short and easy route could be found for a drainage canal across the peninsula between the northerly expansions of the two lakes, but this was proven to be impracticable by the investigations of 1913, which showed that the interior between the lakes was too high and rocky to permit of economical construction.

There was at one time undoubtedly an outlet from the northeast arm of Moose lake by way of the Minago river to the Nelson, and thence to Hudson Bay without touching lake Winnipeg. The Geological Survey Report of 1902 contains a short description of this long since abandoned outlet. According to this report, the water of Moose lake all but overflows the summit of the divide, which is of limestone formation and extends for about 400 yards at an elevation of only about 3 feet above the water. It is said to be 1½ miles over a deep muskeg and this rocky divide, from the open water in Moose lake to a small stream which forms the headwaters of the Minago river. In this stream there are many rapids, and plenty of fall could be obtained in a distance of 9 or 10 miles to lower Moose lake 10 or 12 feet or perhaps more. To do this, however, would be costly and would not accomplish the desired end. It is not sufficient that a portion of the Saskatchewan water, however great, be diverted from the present channel, because even if 90 per cent of the flow should be thus diverted Cedar lake would not be lowered more than 4 or 5 feet, while the remaining 10 per cent would be insufficient for navigation and useless for power purposes. It will never do to divert any material quantity of water from the lower Saskatchewan without regulating works so that it can be turned back again during low water, as it seems to require 30,000 to 40,000 second-feet for navigation purposes, and this is enough to cause flooding. The same may be said of any attempt to divert the water to lake Winnipegosis.

The only complete remedy is by lowering the water of Cedar lake direct by improving the Saskatchewan river between this lake and Cross lake, with perhaps a diversion near Cedar lake and another near Cross lake.

No measurements were taken at the outlet of Cross lake. A short distance below the outlet are Cross lake rapids, with a fall of about 4½ feet from Cross lake to the foot of the rapid. It has been assumed that the outlet from Cross lake is sufficient to prevent the surface ever rising above elevation 820, and that only, in case Cedar lake should rise to elevation 830 under reclamation conditions.

Although, in high water, there is no evidence of any rapids between The Pas and The Narrows, yet in low water there are a few points where considerable current is developed, and this is an indication of what might be expected should the water in Cedar lake be lowered. There is a hard bottom at Brown Rock, Fryingpan, Hill island, and Wooden Tent, and to obtain full benefit of the outlet would probably require some excavation at these points, as well as at Duncan island and Rabbit Point in Cedar lake. It may be possible to avoid the rock at Duncan island by seeking a route farther north.

Lake Winnipegosis.

Lake Winnipegosis lies to the south of Cedar lake, from which it is separated by a narrow strip of land about 4 miles wide at its narrowest point. The land between the lakes is very low on the Cedar lake side, but very high in the vicinity of Winnipegosis. Several surveys have been made at High Portage to determine the relative elevations of the two lakes and the ridge between them.

In 1858 Messrs. A. W. Wells and S. J. Dawson made a survey of the portage, and found the distance between the lakes to be slightly over 4 miles, and the elevation of the water in lake Winnipegosis to be 4 feet higher than the water in Cedar lake.

In 1873, another survey was made by Mr. H. B. Smith, when he found the two lakes to be of equal elevation, and the summit of the ridge was 93.14 feet above the water. The distance between the lakes in a straight line was found to be slightly less than 4 miles.

D. B. Dowling, in 1891, found lake Winnipegosis to be 9 inches above Cedar lake, and the summit of the ridge 93 feet above the water in lake Winnipegosis.

During the past season, I had a temporary gauge placed in Cedar lake, and another in lake Winnipegosis, and these were read daily for eight days, which was the limit of the time possible to spend at this point. Levels were taken between the two gauges, and Winnipegosis was found to be 1½ inches above Cedar lake, and the summit of the ridge was 91·8 feet above Winnipegosis. There seems little doubt that these two lakes are practically at the same level under normal conditions, in spite of the fact that there was a difference in the elevations of 4 feet in 1858; this must have been extremely low water for Cedar lake, and extremely high water for Winnipegosis. What influence keeps the lakes at or near the same level is not apparent; in fact there are many things that would seem to militate against it: Winnipegosis is fed from a comparatively small basin, with nothing but a rather light rainfall to replenish it, while Cedar lake is fed from an immense area whose discharge is rendered extremely variable by the melting snow in summer. It has been suggested that there is a subterranean connection between the lakes, but I consider this extremely doubtful, as water could hardly pass between the lakes in sufficient quantity to materially affect the relative elevations, without so disturbing the surface of the lakes as to make the fact apparent to travellers. Of course, if the opening were of enormous proportions, such as half a mile or more in width, it might not cause a noticeable disturbance.

The lowest point in the ridge between the lakes is believed to be much farther west than High Portage, and is approximately 45 feet above the water.

In considering the feasibility of using lake Winnipegosis as an outlet for the surplus water of the lower Saskatchewan river, I found serious objections, as stated elsewhere in this report; in addition to these, the fact that the two lakes are on the same level makes it out of the question. Of course it is possible, and perhaps desirable, to lower Winnipegosis by cutting a canal across Meadow Portage to Lake Manitoba, and then Cedar lake might be lowered by a canal across at some point west of High Portage; but the cost would be much greater than the cost of improving the Saskatchewan river between Cedar and Cross lakes, and the results infinitely less desirable as regards navigation and power. Mossy Portage is at the south end of lake Winnipegosis, and is about 9,400 feet in length to lake Manitoba. The summit is about 4 feet above lake Winnipegosis, and 23·7 feet above lake Manitoba, according to a survey made by the Public Works Department on April 5, 1913. It is not known how much Winnipegosis could be lowered by a canal at this point, as, although a good bay is reported at the upper end of the portage, there are rock reefs just outside the bay.

Elevations.

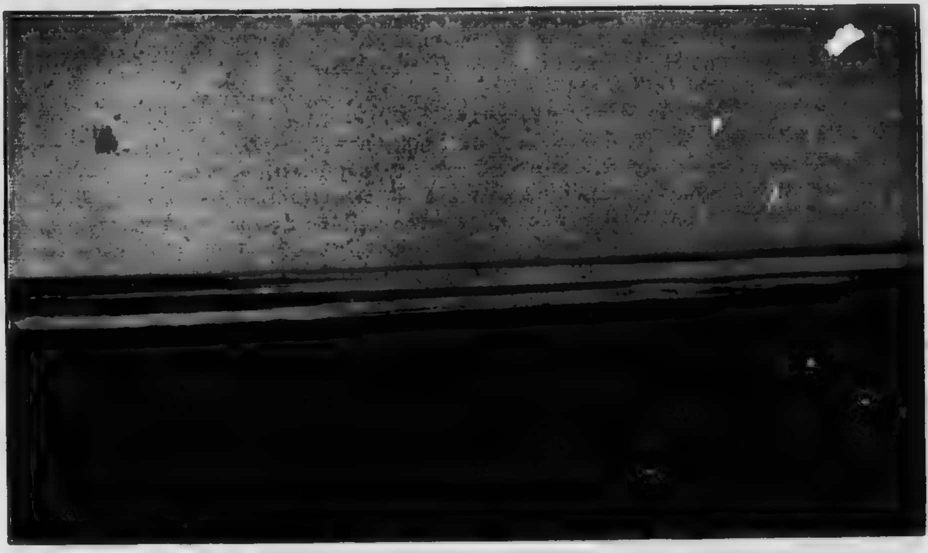
The elevations given in this report, and on the accompanying plans and profile, are based on the elevation of lake Winnipeg above mean sea-level at New York, U.S.A., as established by the United States and Canadian Government Geodetic Surveys, and corrected in 1913.

By a comparison of gauge readings at Winnipeg Beach, and at the mouth of the Saskatchewan river, near Grand Rapids, Manitoba, it was found that a correction of +2.30 feet must be applied to the datum used by Mr. Patterson in his power survey of Grand Rapids. Applying this correction to the elevation given for the bench-mark established by him near the southern extremity of the point of land between Cross lake and Portage bay, I found the corrected elevation to be 824·56.

From this point I started my survey whence I ran a line of levels along the east shore of Cross lake northerly to a point opposite the north end of Block island. The elevation of a bench-mark on the west shore of Cross lake was obtained by water transfer under most favourable weather conditions. On July 5, 1913, the elevation of Cross lake was found to be 818·44 feet above sea-level. A line of levels was run over Cross lake peninsula on cross-section line 8,800, and continued along the northeast shore of the Saskatchewan river to the head of Flying Post rapids, and thence across the river to The Narrows and Cedar lake. At this time the whole of Cross lake peninsula was cross-sectioned and contoured. Gauges were read at Cross lake and Cedar lake during the continuance of our camp in these localities. The elevation of Cedar lake in the small bay at the head of the Flying Post portage was 833·73 feet above sea level on August 11, 1913. As there is a slight fall in the lake between Rabbit Point and The Narrows, I estimated that the mean of Cedar lake on that date was 834·00 feet above sea-level.

As previously stated, a temporary gauge was placed in Cedar lake at the northerly extremity of High Portage, and another in lake Winnipegosis at the southern extremity of the portage; a line of levels was run over the portage, and the gauges read daily for eight consecutive days. Lake Winnipegosis was found to be 0.12 feet higher than Cedar lake. I therefore considered the two lakes to be at the same elevation, viz., 834.00 feet above sea-level.

Levels were continued from the west end of Cedar lake based on water-transfer. and were extended up the Saskatchewan river as far as Brown Rock, a distance of 4 miles above Cedar Lake Post. The elevation of the water at Cedar Lake Post was taken as 834.50, and at Brown Rock it was 836.00 above sea-level on September 25, 1913. These elevations must, however, be considered as a rough approximation. The water elevations given in this report and on the plans, must be read as applying only on the date on which they were taken, but the change of elevation during July and the first part of August was not sufficient to affect materially the water surface shown on the profile accompanying this report.



Pasquia Reclamation Project. Big Lake at low water.

Proposed Improvement.

In designing a canal to lower Cedar lake sufficiently to reclaim the flooded area. it was necessary to determine whether it would be more economical and effective to improve the present river channel by deepening the bed, or by making a new canal independent of the present channel.

To confine the improvement to the present channel would mean the removal of a very large quantity of rock from the Flying Post and Demi-Charge rapids, which would be a difficult and expensive undertaking, especially in the case of the Demi-Charge where the water is very swift and turbulent. It is believed to be much cheaper to cut across the Cross Lake peninsula near its southern extremity than to excavate the Demi-Charge, in spite of the fact that the rock yardage is much in favour of the latter route. At the Cedar lake end it was found that the excavation would be less, and the cost per yard very much less, by cutting across the Narrows peninsula than by following the river by way of Flying Post rapid and around the head of Moose island. A combination of the two routes was, therefore, decided on.

In order to further lessen the cost, and at the same time preserve a sufficient depth of water for navigation during the low water periods, it is deemed advisable to construct two canals, one a low level canal and the other a high level canal. This will permit the low level canal to be made much narrower than would otherwise be the case, and will, by following the present river channel with the high level canal, effect a considerable saving in cost. By constructing the low level canal in sections, commencing at Cross lake, the bottom of the river may be unwatered so as to permit practically dry excavation of the high level canal. If the construction is carried out in this way, there should be less than a million yards of subaqueous excavation.

It is designed to cut a channel 600 feet wide, commencing at elevation 809.00 on the bottom of Cross lake about 900 feet from shore, and leaving the lake between cross-section lines 660 and 1,320, crossing the point of land between the lake and the river, and entering the river between cross-section lines 1320 and 1980, a distance of 2,400 feet from water to water. From this point, the canal will follow the deeper parts of the present river channel to the foot of the Flying Post rapid, a distance of 22,400 feet; thence across The Narrows peninsula to Cedar lake, a distance of 2,500 feet from water to water, and intersecting the bottom of Cedar lake at elevation 813, a distance of 4,250 feet from the shore line in the small bay south of The Narrows, or about 2750 feet from the regular shore line. This constitutes what I have termed the low level canal. The total length of this canal, including portions in Cedar and Cross lakes, will be 32,500 feet. It will be capable of lowering Cedar lake to elevation 817 in winter, and will discharge all the water leaving the lake, so long as the elevation of the lake does not exceed 821.00.

In addition to this low level canal, it is designed to construct a high level canal also 600 feet in width, commencing at a point on the bottom of the Saskatchewan river at or near the head of Demi-Charge rapids, where the plane of elevation 814·00 intersects the bottom of the river and, following the present river channel, as shown on the accompanying plan, to intersect the bottom of Cedar lake at elevation 821.00 beyond the head of Moose island. This channel is not continuous, as the bottom of the river runs below the grade at chainage 18,100, and rises above the grade again at chainage 25,800, leaving a break without excavation of 7,700 feet.

The excavated material can, in most cases, be deposited near the canal, but one side of the river channel should be kept clear for a considerable width to provide for any overflow that might occur in a flood, such as the very extreme and unprecedented one of 1901. It is also important that the river channel be not obstructed on either side at the main curve near the centre of the canal route, nor at a point opposite the channel leading from The Narrows.

The cost might be reduced to some extent by making a cut through The Narrows 200 feet wide, and reducing the cut around the head of Moose island to about 400 feet in width.

There is a possible alternate route for the Cross lake end of the canal which would bear further investigation. It might be found advantageous to take the high level route north of Centre island and, entering the Cross lake peninsula between cross-section lines 7800 and 8800, pass south through the draw indicated on the contour map. On this route considerable soft material would be encountered and, in some places, no excavation would be necessary, as the material is muck and would be entirely removed by the action of the water.

It is desirable that the work of construction be commenced at Cross lake, and that the low level channel be excavated to near Anchor Point before work is commenced on the high level channel, as it is believed that this will have the effect of unwatering the Demi-Charge rapid for the greater portion of the season, and effect a great economy in the cost of excavating the high level channel. This principle can be carried out all through the work until, when the peninsula at The Narrows is cut through and Cedar lake lowered, the whole river bed will be dry from the foot of Flying Post rapid to the head of Moose island, except for a pond between Cedar island and the head of Flying Post, which will be drained by the excavation of Flying Post rapid.

Estimates.

The cost of excavation in the locality of the proposed improvement is very largely affected by a totally unknown item, viz., transportation. There are two routes by which the district may at present be entered, both of which present some difficulties. Machinery and supplies would have to enter either by way of lake Winnipeg, or down the Saskatchewan river from The Pas. Vessels plying on lake Winnipeg are able to enter the mouth of the Saskatchewan river, and to land goods at the foot of Grand rapids about 1½ miles from the lake. From here, it is about 4 miles to the head of Grand rapids over an old horse tramway, or 9 miles to the head of Cross Lake rapids over a wagon road. With this road improved, and with a tug and scows on Cross lake, which is about 4 miles wide, machinery, etc., could be landed at the foot of Demi-Charge rapids. This road would probably not stand much heavy traffic in summer, but would make an excellent winter road; a tramway might be constructed from Grand rapids to Cross lake. The developments of the power at Grand rapids would probably mean the construction of locks and the opening of navigation from lake Winnipeg up the Saskatchewan and this, of course, would solve the question of transportation.

The alternate route down the Saskatchewan river would be an all-rail route as far as The Pas, and from there by water to The Narrows at the western extremity of the proposed canals. Over this route there would be a draft of about 6 feet during high water.

There is at present a winter route from Mafeking, on the Canadian Northern railway, to Grand rapids, a distance of 90 miles. The distance from Mafeking to The Narrows by this route would be about 68 miles and is, therefore, out of the question.

A route which might possibly be developed would run by water from Winnipegosis to High Portage on lake Winnipegosis, and thence 4 miles over the portage to Cedar lake. There is at present a wagon road over High Portage which is high, except for a short distance at the Cedar lake end which is corduroyed.

Among the various elements of uncertainty usually present in every estimate, there is another outstanding one, which is the classification of materials. As it was not practicable to make borings, no real classification could be made. It was evident, however, that very much more rock would have to be excavated than was at first anticipated and, after considering the matter carefully, I have estimated it roughly at 65 per cent of the total excavation, including loose rock, the remaining 35 per cent being earth or uncemented gravel.

In view of the uncertainty regarding transportation and classification, I have not attempted to make a precise detailed estimate of all the items that go to make up the cost of excavation.

The cost of excavating limestone rock in the Chicago drainage canal averaged about 50 cents per cubic yard, or perhaps a little less, while in some cases the cost was as low as 40 cents. The difference in cost was due to different methods of handling and not to a difference in the rock.

The rock to be excavated in the Cedar lake drainage canal is a magnesic limestone or Dolomite, and is thin-bedded and shaly in places, but much thicker in others

The total estimated number of cubic yards to be excavated between Cedar and Cross lakes and, including the approaches in each lake, is 8,794,200, which may be roughly classified as follows:—

Low Level Channel.

	Yards
Cross Lake peninsula	977,511
Old river-bed	3,386,008
The Narrows peninsula	2,652,622
Total yards in Low Level canal	7,016,141

High Level Channel.

Anchor Point cut	751,037
Moose Island and Flying Post cut	1,027,022
Total yards in High Level canal	1,778,059

Making a total of 8,794,200 yards in both canals.

As 65 per cent of this yardage is estimated to be rock and 35 per cent earth we have:—

Earth, dry, 1,750,000 yards at 12 cents	$ 210,000 00
" wet, 1,327,970 yards at 20 cents	265,594 00
Rock, dry, 3,000,000 yards at 85 cents	2,550,000 00
" wet, 2,000,000 yards at $1.65	3,300,000 00
" loose, 716,230 yards at 40 cents	286,492 00
Total for excavation	$6,612,086 00
Add for engineering, 2 per cent	132,242 00
Add for contingencies, 10 per cent	661,209 00
	$7,405,537 00
Add for interest during construction, five years at 4 per cent	444,332 00
Total cost of High and Low Level canals	$7,849,869 00
Estimate for work in Cedar lake and Saskatchewan river	400,000 00
Total cost of work	$8,249,869 00

It may be thought that the above unit prices are, in some circumstances, too low but it is believed that the enormous quantities to be removed justify a moderately low estimate.

It will be seen that this estimate is very much in excess of my former estimate for the same work. This is due to a change in classification which calls for the excavation of a much greater quantity of rock, and particularly of subaqueous rock.

This estimate is made on the basis of a continuation of the present conditions west of The Pas. Should improvements in that section tend to reduce the storage, the discharge at The Narrows would be somewhat increased but the amount of this increase would depend on the nature of the improvement.

Area to be Reclaimed.

To determine the area and value of the land which it is proposed to reclaim in the eastern Pasquia district will require a special survey on which a small party might easily spend a whole season without fully completing the work. No survey of the boundaries of this district has ever been made and the divide between the Saskatchewan river and Overflowing river has never been definitely located.

The total area tributary to the Saskatchewan river east of The Pas is approximately 5,200 square miles, while the area which has generally been considered as affected in some degree by the overflow of the Saskatchewan is roughly 2,650 square miles, or about 1,700,000 acres. This is the area within the dotted ~~blue~~ red line on the field plan but does not include any of Cedar lake or Moose lake, which together occupy about 700 square miles within the ~~blue~~ red line. A very considerable portion of Cedar lake will, however, be unwatered at the west end, and much good land be reclaimed. No doubt a large part of the bottom of Moose lake will also be uncovered, but it will probably be of little value for agricultural purposes.

The area drained by Overflowing river is approximately 690,000 acres. It flows into lake Winnipegosis, and is not included in any of the computations in this report.

The whole delta country at the west end of Cedar lake, together with the extensive rush-covered areas extending westward along the Saskatchewan river and northward to Moose lake, will undoubtedly make good land, and will receive immediate relief upon the lowering of Cedar lake. This area is probably not less than 400,000 acres in extent.

There are rocky areas around Cedar lake that are but thinly covered with soil, and still other quite extensive areas that can be classed as nothing else than muskegs. Such lands must for the present, and for a long time to come, be considered of very small value indeed. The absence of definite information as to the extent of the good land, and the value of the poorer grades, prevents even an approximate estimate.

Cedar lake.

The maximum elevation of Cedar lake in 1913 was 834·00 feet above sea-level, while in 1912 it was approximately 836·00 feet. The maximum discharge for 1913 occurred at The Pas on July 29, and amounted to 63,800 cubic feet per second. This occurred only on one day, but it was over 63,000 second-feet for a week, and over 60,000 second-feet for twenty-eight days. With the construction of the proposed works, the storage east of The Pas would be eliminated, and the run-off from the catchment area between The Pas and The Narrows would, as previously stated, be 8,400 second-feet. The maximum discharge at The Narrows would, therefore, be 63,800 + 8,400 = 72,200 second-feet. With the two canals constructed and the lake lowered, this discharge, if continued long enough, would raise the lake to elevation 827·00, or possibly a little higher; under the conditions prevailing in 1913, the elevation would probably be a little less than 827·00 at the maximum. By an examination of the discharge curve for the two canals, we find the combined discharge to be 71,500 second-feet at elevation 827·00. This means a minimum lowering of Ceda lake in 1913, by the construction of the canals, of 7 feet.

In 1912, the maximum discharge at The Pas was 73,870 second-feet, which i equivalent to 82,270 second-feet discharge at The Narrows. With the canals con structed and the lake lowered, this flow, if persisted in, would raise the lake to nea elevation 828·00 feet. The combined discharge of the two canals is 83,700 second feet at elevation 828·00. The maximum elevation of Cedar lake under reclamatio conditions in 1912 would, therefore, be somewhat less than 828·00 and, since th actual elevation was 836, the minimum reduction in elevation due to constructio would be a little over 8 feet.

Should the canals be constructed as proposed, Cedar lake would rise in ordinar high water years to elevation 826·00, and occasionally to 827·00. In very high wat years it would rise to 827·50, and very rarely perhaps to 828·00; but there is litt likelihood that it would ever exceed 828·00 as, at this elevation, it would begin discharge through the old river-bed which would prevent further rise.

The maximum elevation of Cedar lake would be reduced about 8 feet under co struction, and it is believed that this will provide an outlet sufficient to reclaim all t area covered by the application, when such minor drains as may be necessary to ma this outlet available have been constructed.

Time for Completion.

The time required for the completion of the work proposed in this report will depend on the equipment and management. In a work of this size there is room for an almost unlimited amount of machinery. I do not, however, consider that the canals could be completed in less than four years without making the undertaking unnecessarily expensive.

The excavation of 8,794,200 yards in 4 years requires the removal of over 2,000,000 yards per year, and the working season will probably be limited to eight months. This amounts to 250,000 yards per month of earth and rock. Only the largest sized shovels could be used to advantage in this work, and it would probably require seven or eight of these.

Pasquia Reclamation Project. Saskatchewan River. Shore line near Frying Pan Rapids.

The work at Rabbit Point could be carried on simultaneously with the work on the canals, and the work at Duncan island and in the river farther west should be left until after Cedar lake is lowered, as much of the work which now seems imperative may then be found to be unnecessary.

Navigation.

As stated in my report of last year, the navigation of the lower Saskatchewan, as it is at present, is very unimportant, being confined to occasional trips with supplies to the Hudson's Bay Company's posts at Cedar and Moose lakes. This traffic is carried in vessels of light draft, as 3 feet of water is all that can be depended on in some places in the Saskatchewan river near the west end of Cedar lake, where many bars have been formed by the deposit of sediment. A great deal of work is necessary to make the river suitable for navigation by vessels of 6 feet draught. Any work done for the purpose of improving the river or lakes, with a view to better drainage, will prove a benefit to navigation, as it will have the effect of removing the bars and other obstructions and distributing the fall, making it more uniform throughout the [illegible]

The low level canal which it is proposed to construct between Cedar lake and Cross lake will have a width of 600 feet, and the water at the peak of the flood may have a velocity of 6 feet per second, or even more. This would be over four miles per hour, and might be dangerous at the curve where the channel through The Narrows peninsula joins the river. This could be remedied by a change in the alignment of the canal at this point, should the navigation of this part of the river ever become a live issue through the construction of a dam and locks at Grand Rapids. The big curve, which is located about half-way between the lakes, will not form any menace to navigation, as there is very little excavation at this point, and the navigable channel will be very much wider than the canal. This will have the double effect of reducing the velocity, and providing plenty of room for a vessel to manœuvre in. It should be noted, however, that this canal is designed especially for drainage purposes and not for navigation, although the idea of a narrow deep canal answers well for both purposes. The canal could be straightened at an increased cost, which would make it more readily navigable, and increase the discharge at the same time. There will be no difficulty, however, in navigating the canal, except possibly at the one point mentioned, and then only at extremely high water, if at all. This stretch of the river is at present unnavigable and, without the construction of this proposed drainage canal, could only be rendered navigable at enormous expense. It has been suggested that a canal and lock be constructed to overcome the Demi-Charge rapids, and that a dam be built across the river from Anchor Point at the head of the canal, to flood out the Flying Post rapids. This plan would meet with considerable difficulty, as the water could not be held up above elevation 829 without the construction of a second dam as long as the first one, owing to the existence of a draw to the north and east of the rocky ridge which trails for a short distance along the east shore at this point. It therefore seems desirable that, if there should be an insistent demand for the navigation of this part of the river, it should be worked out in conjunction with this drainage scheme.

The canal is designed to follow the deeper parts of the river, with a view to economy of construction. Undoubtedly the navigability of the river will be greatly improved by the construction of the drainage works herein proposed.

Power.

The interests of drainage are, in this case, opposed to those of water-power, for the reason that the minimum flow in the river is very small indeed, being only 4,000 or 5,000 second-feet, and to regulate the flow requires a very large storage area. The interests of reclamation demand that storage be done away with, that the lands be protected from flooding, and that the lakes into which they drain have a free outlet.

It is true that the water in Cedar lake could be so regulated as to increase the winter flow to some extent, but it would be of little value, and this treatment would require a larger canal to prevent the lake from rising too high during the flood period.

As the power at Grand Rapids is being investigated by the Water Power Branch, any discussion of it is out of place at this time.

SUMMARY.

Judging from the information that has been secured and recorded in the foregoing report, I am of the opinion that the area applied for, viz., the eastern Pasquia district, may be reclaimed at a cost of approximately ~~$7,100,000,~~ $1,250,000, exclusive of the cost of the service drains which are necessary to connect the interior districts with the outlet; that the cost of the work seems out of proportion to the benefits to be derived, but the value of the lands thus reclaimed is not known with sufficient accuracy to justify an expression of opinion as to the economy of the scheme; that the navigability of the river will be greatly improved by the construction of the works; that the interests o water-power development at Grand Rapids will be adversely affected, and that the time required for the completion of the canals will be not less than four years from the time excavation is actually commenced.

CONCLUSION.

In a consideration of this report and estimates, due allowance must be made for the indefiniteness arising from lack of data concerning the value and extent of the reclamation district, the classification of materials of excavation, the nature and extent of the work, which may be necessary west of The Narrows, and such other matters as have been cited in the report.

From the information presented herein, I do not consider the proposition a very attractive one as an investment at the prevailing price of land. A more intimate knowledge of the value of the lands in the interior might, however, make it necessary to alter this view.

It seems probable, however, that with the completion of the proposed power development at Grand Rapids and the consequent opening up of the Saskatchewan river to navigation, and the cheap power and cheap transportation thus supplied, the cost of constructing the Cedar lake drainage canals would be much reduced. If, in addition, the drainage scheme could be worked out in conjunction with the navigation plans of the Department of Public Works, and the reclamation scheme now being investigated west of The Pas, with a fair division of the costs, there is no doubt that the reclamation and sale of the lands in the eastern Pasquia district could be made to return a fair profit on the investment.

The drainage and settlement of this immense district is most desirable, and of great importance to the province of Manitoba, as well as to Canada, not only because of the agricultural and industrial development of the flooded district itself, but because of the adjoining areas which are at present more or less isolated or rendered undesirable by the proximity of the wet and swampy areas, and also because it is by the drainage of this area that the very desirable and enormous flooded area west of The Pas may best be reclaimed.

I have the honour to be, sir,

Your obedient servant,

THOS. H. DUNN,

Chief Engineer of Reclamation.

DISCHARGE MEASUREMENTS of Saskatchewan River near The Pas, 1912-13.

DATE.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity	Gauge height.	Discharge
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
1912.							
Oct. 21, 22	W. G. Worden	1,196	914	18,093	2·11	......	38,123
Dec. 14	G. J. Lamb	1,187	834	12,848	0·68	......	*8,772
1913.							
Feb. 8, 9	A. Pirie	1,469	771	9,563	0·53	......	*5,105
Apr. 9	"	1,186	775	10,548	0·72	......	*7,562
May 31	E. Bankson	1,469	761	14,233	3·10	9·46	45,182
June 4	G. Ebner	1,186	750	13,331	3·31	9·37	44,124
" 10	"	1,186	750	13,899	3·38	9·79	46,979
" 12	"	1,186	760	14,041	3·51	10·14	49,285
" 14	"	1,186	739	14,197	3·63	10·35	51,534
July 10	"	1,196	758	15,446	3·69	11·98	56,948
" 12	"	1,196	760	15,587	3·58	12·15	57,743
" 15	"	1,196	756	15,848	3·79	12·37	60,114
" 18	"	1,196	756	16,000	3·9[illegible]	12·58	62,883
" 21	"	1,196	780	16,066	3·98	12·76	63,970
" 23	"	1,196	673	16,107	3·86	12·80	62,120
" 25	"	1,196	756	16,309	3·93	12·91	64,199
" 28	"	1,196	750	16,342	3·91	12·96	63,869
" 30	"	1,196	756	16,332	3·85	12·94	63,025
Aug. 1	"	1,196	756	16,311	3·[illegible]2	12·85	62,385
" 4	"	1,196	756	16,146	3·84	12·65	62,029
" 6	"	1,196	756	16,043	3·75	12·50	60,357
" 28	W. J. Ireland	1,469	774	15,229	3·62	11·41	55,101
Sept. 20	"	1,469	729	13,422	3·03	8·98	40,707
Oct. 9	C. O. Allen	1,435	648	11,040	2·50	6·07	27,532
" 23	"	1,435	648	11,171	2·15	6·35	†24,025
Nov. 18	A. Pirie	1,496	830	12,938	0·92	3·70	*11,890

*Ice Measurement.

†Ice running in river.

APPROXIMATE DAILY GAUGE HEIGHT AND DISCHARGE for the year 1912, Saskatchewan River near The Pas, Manitoba.

(Drainage area, 149,500 square miles.)

Day.	APRIL.		MAY		JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		Day.
	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	
1	....	....	10·8	52,140	8·6	40,480	8·25	38,625	13·8	68,040	13·4	65,920	13·1	64,330	7·7	35,710	1
2	....	....	11·2	54,260	8·6	40,480	8·4	39,420	13·8	68,040	13·4	65,920	13·0	63,800	7·5	34,650	2
3	....	....	11·1	53,730	8·6	40,480	8·5	39,950	13·8	68,040	13·45	66,185	12·9	63,270	7·3	33,590	3
4	....	....	11·0	53,200	8·6	40,480	8·7	41,010	13·8	68,040	13·45	66,185	12·7	62,210	7·4	34,120	4
5	....	....	10·8	52,140	8·6	40,480	8·9	42,070	14·6	72,280	13·45	66,185	12·5	61,150	7·5	34,650	5
6	....	....	10·3	49,490	8·6	40,480	9·1	43,130	14·9	73,870	13·45	66,185	12·3	60,090	7·6	35,180	6
7	....	....	10·1	48,430	8·7	41,010	9·3	44,190	14·9	73,870	13·45	66,185	12·1	59,030	7·6	35,180	7
8	....	....	9·8	46,840	8·9	42,070	9·5	45,250	14·9	73,870	13·45	66,185	11·9	57,970	7·65	35,445	8
9	....	....	9·6	45,790	9·0	42,600	9·75	46,575	14·8	73,340	13·45	66,185	11·7	56,910	7·75	35,975	9
10	....	....	9·5	45,250	9·0	42,600	10·0	47,900	14·7	72,810	13·45	66,185	11·55	56,115	7·9	36,770	10
11	....	....	9·3	44,190	9·05	42,865	10·25	49,225	14·6	72,280	13·5	66,450	11·35	55,035	8·05	37,565	11
12	....	....	9·2	43,660	8·9	42,070	10·6	51,080	14·5	71,750	13·55	66,715	11·15	53,955	8·25	38,625	12
13	....	....	9·1	43,130	8·8	41,540	10·8	52,140	14·4	71,220	13·6	66,980	10·9	52,670	8·4	39,420	13
14	....	....	8·8	41,540	8·7	41,010	11·0	53,200	14·3	70,690	13·6	66,980	10·7	51,610	8·5	39,950	14
15	....	....	8·7	41,010	8·6	40,480	11·2	54,260	14·25	70,425	13·6	66,980	10·5	50,550	8·5	39,950	15
16	....	....	8·8	41,540	8·5	39,950	11·4	55,320	14·2	70,160	13·6	66,980	10·3	49,490	8·5	39,950	16
17	....	....	8·8	41,540	8·3	38,890	11·5	55,850	14·15	69,895	13·6	66,980	10·1	48,430	8·55	40,225	17
18	....	....	8·8	41,540	8·2	38,360	11·6	56,380	14·1	69,630	13·6	66,980	9·9	47,370	8·55	40,225	18
19	....	....	8·75	41,245	8·0	37,300	11·7	56,910	14·0	69,100	13·6	66,980	9·7	46,310	8·55	40,225	19
20	....	....	8·75	41,245	7·8	36,240	11·9	57,970	13·9	68,570	13·6	66,980	9·5	45,250	8·6	40,480	20
21	....	....	8·6	40,480	7·6	35,180	12·2	59,560	13·8	68,040	13·6	66,980	9·3	44,190	8·6	40,480	21
22	....	....	8·6	40,480	7·3	33,590	12·4	60,620	13·75	67,775	13·6	66,980	9·2	43,660	8·6	40,480	22
23	....	....	8·6	40,480	7·2	33,060	12·6	61,680	13·7	67,510	13·6	66,980	9·1	43,130	....	....	23
24	....	....	8·6	40,480	7·0	32,000	12·8	62,740	13·6	66,980	13·6	66,980	9·0	42,600	....	....	24
25	....	....	8·6	40,480	6·8	30,940	13·0	63,800	13·55	66,715	13·55	66,715	8·9	42,070	....	....	25
26	10·3	49,490	8·6	40,480	6·9	31,470	13·2	64,860	13·5	66,450	13·55	66,715	8·8	41,540	....	....	26
27	10·2	48,960	8·6	40,480	7·2	33,060	13·3	65,390	13·4	65,920	13·5	66,450	8·65	40,745	....	....	27
28	10·3	49,490	8·6	40,480	7·3	33,590	13·4	65,920	13·4	65,920	13·4	65,920	8·5	39,950	....	....	28
29	10·5	50,550	8·6	40,480	7·9	36,770	13·5	66,450	13·4	65,920	13·3	65,390	8·35	39,155	....	....	29
30	10·6	51,080	8·6	40,480	8·1	37,830	13·6	72,280	13·4	65,920	13·2	64,860	8·1	37,830	....	....	30
31	....	....	8·6	40,480	....	....	13·7	67,510	13·4	65,920	....	....	7·9	36,770	....	....	31

NOTE.—These gauge readings refer to the Water Power gauge at the H.B. Ry. Bridge and are reduced from the readings on the Public Works gauge at the Pas River dock. They must be considered as an estimate.

DAILY GAUGE HEIGHT AND DISCHARGE for the year 1913, Saskatchewan River near The Pas.

(Drainage area, 149,500 square miles.)

Day.	April.		May.		June.		July.		August.		September.		October.		Day.
	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	
1	......	......	12·30	60,090	9·45	44,985	11·50	55,850	12·85	63,005	11·35	55,055	......	......	1
2	......	......	·30	60,090	·40	44,720	·50	55,850	·80	62,740	·24	54,472	......	......	2
3	......	......	·30	60,090	·30	44,190	·60	56,380	·70	62,210	·10	53,730	......	......	3
4	......	......	·20	59,560	·40	44,720	·70	56,910	·65	61,945	11·00	53,200	......	......	4
5	......	......	·24	59,772	·35	44,455	·80	57,440	·60	61,680	10·90	52,670	......	......	5
6	......	......	12·25	59,825	9·30	44,190	11·80	57,440	12·50	61,150	10·86	52,458	......	......	6
7	......	......	·20	59,560	·30	44,190	·85	57,705	·50	61·150	·86	52,458	......	......	7
	......	......	·40	60,620	·50	45,250	·83	57,599	·40	60·620	·70	51,610	6·30	28,290	8
9	......	......	·60	61,680	·60	45,780	·90	57,970	·30	60·090	·50	50,550	·12	27,336	9
10	......	......	·80	62,740	·80	46,840	·90	57,970	·20	59·560	·26	49,278	5·95	26,435	10
11	......	......	11·20	54,260	9·80	46,840	12·00	58,500	12·25	59,825	10·20	48,960	5·95	26,435	11
12	......	......	·30	54,790	10·00	47,900	·10	59,030	·25	59·825	·00	47,900	·58	24,474	12
13	7·2	33,060	·50	55,850	·20	48,960	·40	60,620	12·00	58,500	9·90	47,370	......	......	13
14	·3	33,590	·60	56,380	·35	49,755	·30	60,090	11·90	57,970	·75	46,575	......	......	14
15	·4	34,120	·70	56,910	·40	50,020	·40	60,620	·90	57,970	·60	45,780	......	......	15
16	9·25	43,925	11·50	55,850	10·50	50,550	12·40	60,620	11·90	57,970	9·30	44,190	......	......	16
17	10·20	48,960	·30	54,790	·60	51,080	·50	61,150	·80	57,440	·17	43,501	......	......	17
18	·90	52,670	10·20	48,960	·70	51,610	·60	61,680	·70	56,910	·04	42,812	......	......	18
19	11·20	54,260	·25	49,225	·90	52,670	·60	61,680	70	56,380	·10	43,130	......	......	19
20	12·20	59,560	·23	49,119	11·00	53,200	·70	62,210	50	55,850	·05	42,865	......	......	20
21	11·65	56,645	10·30	49,490	11·00	53,200	12·80	62,740	11·40	55,320	8·54	40,162	......	......	21
22	·50	55,850	·20	48,960	·00	53,200	·80	62,740	·40	55,320	·42	39,526	......	......	22
23	·60	56,380	·00	47,900	·90	57,970	·80	62,740	·35	55,055	·34	39,102	......	......	23
24	·70	56,910	9·60	45,780	·80	57,440	·80	62,740	·40	55,320	·25	38,625	......	......	24
25	·90	57,970	·50	45,250	·70	56,910	·90	63,270	·40	55,320	·14	38,042	......	......	25
26	12·00	58,500	9·55	45,515	11·60	56,380	12·95	63,535	11·40	55,320	7·81	36,293	......	......	26
27	12·20	59,560	·50	45,250	·50	55,850	·95	63,535	·39	55,267	·74	35,922	......	......	27
28	·20	59,560	·40	44,720	·50	55,850	·95	63,535	·43	55,479	·20	33,060	......	......	28
29	·35	60,355	·50	45,250	·50	55,850	13·00	63,800	·40	55,320	......	......	......	......	29
30	......	......	·50	45,250	·50	55,850	12·90	63,270	·40	55,320	......	......	......	......	30
31	......	......	·50	45,250	......	......	·90	63,270	·30	54,790	......	......	......	......	31

DISCHARGE MEASUREMENTS of Saskatchewan River near Grand Rapids, Man., 1909.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Dis-charge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
Oct. 21	F. A. Forward..........	....	876	5,714	89 2% 4·84	....	24,669

Above rapids. No wind. Surface floats. Mean of five good results taken. Course = 1,100 ft. Mean time for course = 227·4 sec. Surface rate of flow = 4·84 ft. sec. Ratio mean to surface flow = 89·2 for roughly contoured rock bottom. H.W. level six feet above present level. Flood section = 11,114 sq. ft. Probable rate of flow = 6 ft. sec. The maximum discharge = 66,684 sec. ft.

DISCHARGE MEASUREMENTS of Saskatchewan River near Grand Rapids, Man., 1910.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Dis-charge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
1910. July.....	Wm. Ogilvie..............	....	1,048	13,341	2·65	786·22	35,322
October.	"		....	....	....	....	24,433

Taken on section later used by W.P.S. Approximate elevation of gauge = 786·22.

DISCHARGE MEASUREMENTS of Saskatchewan River at Grand Rapids, 1912.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Dis-charge.
			Feet.	Ft. per sec.	Feet.	Sq. ft.	Sec.-ft.
Aug. 8	E. B. Patterson...	285	1,055	15,061	3·47	788·18	52,262
Sept. 18	"	3	1,056	15,853	4·01	788·96	63,570
Sept. 23	"	3	1,058	15,957	3·98	789·06	63,510

DISCHARGE MEASUREMENTS of Saskatchewan river at Grand Rapids, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Dis-charge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec. ft.
Aug. 27	A. Pirie....................	1496	1,054	15,422	3·71	788·31	57,206
Aug. 29	"	1497	1,054	15,485	3·57	788·36	55,266
Aug. 30	"	1497	1,05.	15,427	3·55	788·29	54,718
Nov. 10	"	1496	1,016	11,872	1·66	786·01	19,727
Nov. 11	"	1496	1,012	11,963	1·71	785·97	20,548

DAILY GAUGE HEIGHT AND DISCHARGE for the year 1912, Saskatchewan River near Head of Grand Rapids.

DAY.	AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
1	....	....	788·79	62,000	....	65,000	....	38,750
2	....	....	·84	62,750	....	65,000	....	38,750
3	787·88	48,500	·80	62,000	....	65,000	....	38,750
4	....	49,000	·74	61,250	....	65,000	787·23	38,750
5	787·93	49,250	·77	61,250	....	65,000	....	38,750
6	788·00	50,000	788·89	63,500	....	65,000	....	37,250
7	·04	50,750	789·11	66,500	789·02	65,000	....	35,750
8	·13	52,250	....	66,250	....	66,500	....	34,250
9	·21	53,000	....	66,000	....	68,000	....	32,750
10	....	51,500	789·06	65,750	....	69,500	....	31,250
11	....	50,000	788·99	65,000	....	71,000	786·67	29,750
12	....	48,500	·99	65,000	....	72,500	....	29,000
13	....	47,000	789·07	65,750	....	74,000	....	28,250
14	787·82	47,000	788·96	64,250	789·60	74,000	....	27,500
15	....	47,000	·98	65,000	....	74,000	....	26,750
16	....	47,000	788·99	65,000	....	74,000	....	26,000
17	....	47,750	·94	64,250	....	74,000	....	25,250
18	....	47,750	·96	64,250	....	72.500	786,28	24,500
19	787·83	47,750	·98	65,000	....	72,500	....	24,500
20	....	47,750	789·01	65,000	....	72,500	....	24,500
21	....	47,000	788·99	65,000	789·50	72,500	....	23,750
22	787·79	47,000	789·01	65,000	....	67,250	....	23,750
23	....	50,750	·10	66,500	....	62,000	....	23,000
24	....	54,500	·06	65,750	....	56,750	....	23,000
25	....	57,500	788·96	64,250	....	51,500	786·22	23,000
26	788·74	61,250	....	64,250	....	46,250	....	....
27	....	61,250	....	64,250	....	41,000	....	....
28	....	61,250	....	64,250	787·29	39,500	....	....
29	....	61,250	....	64,250	....	39,500	785·45	....
30	....	62,000	....	64,250	....	39,500	....	....
31	....	62,000	....	....	....	39,500	....	....

DAILY GAUGE HEIGHT AND DISCHARGE for the year 1913, Saskatchewan River near Head of Grand Rapids.

Day.	MAY.		JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		Day.
	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	
1				48,500		46,500		54,500		53,000		39,950		24,500	1
2			787·89	48,500		46,500		54,500	788·19	53,000		39,500		23,900	2
3				48,500		46,500		54,500		52,550		39,050		23,300	3
4				48,500		47,500	788·29	54,500		52,100		38,600		22,700	4
5				47,500		47,500		54,500		51,650		38,150		22,100	5
6				47,500		47,500		54,500		51,200		37,700		21,500	6
7				46,500	787·89	48,500		54,500		50,750		37,250	786·12	21,500	7
8				46,500		48,500		56,000		50,300		36,800	·06	20,750	8
9			787·69	45,500		48,500		56,000		49,850		36,350	·25	23,750	9
10				45,500		48,500		56,000		49,400		35,900	785·95	19,250	10
11				45,500		47,000	788·39	56,000		48,950		35,450	785·96	19,250	11
12				45,500		47,000		56,000		48,500		35,000	·01		12
13				45,500		47,000		56,000		48,050	786·99	35,000	·06		13
14				45,500	787·79	47,000		56,000		47,600	·97	34,250	784·95		14
15				45,500		48,000		54,500		47,150	·96	34,250	·78		15
16			787·69	45,500		49,000		54,500		46,700	786·92	33,500			16
17				45,500		50,000		54,500		46,250		33,500			17
18				45,500		51,000	788·29	54,500		45,800		32,900			18
19	786·99	35,000		45,500		52,000		54,500		45,350		32,300			19
20		37,250		45,500		53,000		55,250		44,900		31,700			20
21		39,500		45,500	788·29	54,500		55,250		44,450		31,100			21
22		41,750		45,500		54,500		56,000		44,000		30,500			22
23		44,000	787·69	45,500		54,500		56,000		43,550		29,900			23
24		46,250		45,500		54,500		56,000		43,100		29,300			24
25		48,500		45,500		56,000		56,750		42,650		28,700			25
26	787·99	50,000		45,500		56,000	788·45	56,750		42,200		28,100			26
27		50,000		45,500		56,000	788·33	55,250		41,750		27,500			27
28		50,000		45,500	788·39	56,000		55,250		41,300		26,900			28
29		50,000		45,500		56,000	788·38	56,000		40,850		26,300			29
30		48,500	787·69	45,500		56,000	·31	54,500		40,400		25,700			30
31		48,500				56,000		54,500				25,100			31

PRECIPITATION, The Pas, Man. Latitude, 53° 49′; longitude, 101° 15′.

—	1910.	1911.	1912.	1913.
	inches.	inches.	inches.	inches.
January	....	....	0·02	1·17
February	....	0·20	0·14	0·27
March	....	0·52	0·49	0·06
April	....	2·64	....	....
May	....	1·18	0·56	1·51
June	....	....	1·22	....
July	2·60	4·67	4·39	2·42
August	3·27	2·35	2·61	2·92
September	1·92	1·92	3·54	....
October	0·57	0·40	0·82	0·61
November	2·43	1·65	1·65	0·33
December	0··1	0·70	0·60	0·13

PRECIPITATION, Swan River, Man. Latitude, 52° 06′; longitude. 101° 15′.

—	1909.	1910.	1911.	1912.
	inches.	inches.	inches.	inches.
January	....	0·10	....	0·20
February	....	0·50	....	0·30
March	....	0·45	....	....
April	....	1·86	0·31	....
May	0·73	2·63	2·96	....
June	2·21	3·17	3·52	....
July	3·67	1·30	2·64	....
August	2·57	4·47	3·68	....
September	0·49	0·79	2·37	....
October	0·89	0·22	1·12	....
November	0·80	0·75	1·40	....
December	....	1·30	1·20	....

PRECIPITATION, Melfort, Sask. Latitude, 52° 47′; longitude, 104° 30′.

—	1909.	1910.	1911.	1912.	1913.
	inches.	inches.	inches.	inches.	inches.
January	....	0·05	0·80	0·10	0·95
February	....	0·50	0·20	0·40	0·15
March	....	0·20	0·20	0·95	0·55
April	....	1·07	1·57	0·47	0·50
May	....	0·81	1·60	1·88	1·43
June	....	1·32	3·07	3·60	....
July	....	2·10	4·28	6·04	3·90
August	....	2·66	2·65	2·23	2·27
September	0·74	0·84	1·61	2·71	....
October	0·51	1·03	1·10	0·29	0·47
November	0·26	0·40	1·70	0·34	0·20
December	....	1·80	0·40	0·50	0·15

Precipitation, Cumberland, Sask. Latitude, 53° 56′; longitude, 102° 16′.

Year, 1911.	Inches.
January	
February	
March	
May	
April	
June	3.69
July	3.95
August	3.95
September	3.60
October	0.60
November	2.55
December	

Precipitation, Lost River, Sask. Latitude, 52° 17′; longitude, 104° 21′.

	1911	1912	1913
	inches.	inches.	inches.
January			
February			
March			
April		1·14	0·52
May		2·56	
June	3·21		2·10
July	1·29	5·18	5·36
August	1·56	2·40	4·46
September	1·63	4·20	
October	1·09	0·45	0·-2
November	0·54		
December			

Temperature, The Pas, Man. Latitude, 53° 49′; longitude, 101° 15′.

Year, 1910.	Mean.	Maximum	Date.	Miminum	Date.
	°	°	°	°	
January					
February					
March					
April					
May					
June	61·8	86	21	30	1
July	64·5	85	18	46	31
August	56·8	80	19	30	27
September	46·4	74	16	24	23
October	40·0	74	9	19	19 & 28
November	13·9	27	12	−2·5	10
December	2·2	34		−42	

TEMPERATURE, The Pas, Man. Latitude, 53° 49′; longitude, 101° 15′.

Year, 1911.	Mean.	Maximum	Date.	Minimum	Date.
	°	°		°	
January	...	...	...	...	...
February	0·6	39·0	24	-42·0	4
March	13·5	47·0	13	-16·0	5
April	33·0	70·0	24 & 25	-8·0	2
May	48·2	83·2	5	22·0	1
June	...	...	...	...	...
July	59·0	8–·0	26	43·0	17
August	57·6	81·0	19	34·0	25
September	46·0	67·1	2	15·0	27
October	38·3	79·0	9	3·0	31
November	9·9	40·0	3	-17	11-14
December	3·5	35·0	3	-51	29

TEMPERATURE, The Pas, Man. Latitude, 53° 49′; longitude, 101° 15′.

Year 1912.	Mean.	Maximum	Date.	Minimum	Date.
	°	°		°	
Januray	-7·7	23·0	30	-54·0	10
February	-2·3	34·0	16	-34·0	25
March	2·9	35·0	27	-32·0	1
April	...	...	...	...	...
May	57·5	82·0	25	26·0	19
June	61·5	92·0	27	34·0	2
July	58·0	82·0	1	38·0	21
August	58·3	80·0	10	40·0	27
September	48·6	76·0	11	26·0	26
October	38·6	65·0	1	17·9	30
November	22·3	36·0	2	-8·0	29
December	4·3	38·0	27	-26·0	2

TEMPERATURE, The Pas. Man. Latitude, 53° 49′; longitude, 101° 15′.

Year, 1913.	Mean.	Maximum	Date.	Minimum.	Date.
	°	°		°	
January	-17·9	12·0	29	-51·0	...
February	5·2	18·0	22	-33·0	...
March	2·8	42·0	31	-36·0	...
April	...	...	...	...	...
May	46·1	79·0	30	22·0	...
June	...	...	...	...	...
July	63·0	83·0	29 & 30	41·0	...
August	61·4	80·0	20 & 29	38·0	...
September	...	...	...	...	...
October	31·4	62·2	1	2·0	...
November	21·7	63·2	4	-3·0	...
December	12·1	40·0	4	-27·0	24

TEMPERATURE, The Pas, Man. Latitude, 53° 49′; longitude, 101° 15′.

Year, 1914.	Mean.	Maximum	Date.	Minimum.	Date.
	°	°		°	
January	-2·3	30·0	5	-32·0	20

TEMPERATURE AND BAROMETRIC READINGS. Eastern Pasquia District.

Date.	Temperature.		Barometer.		Remarks.
	Max.	Min.	A. M.	P. M.	
1912.	°	°	In.	In.	
August 2	73	54	30·15	30·00	
" 3	77	53	30·25	29·91	Fair.
" 4	74	54	28·91	29·97	Fair.
" 5	75	52	28·72	28·85	Cloudy.
" 6	74	46	28·79	28·70	Cloudy and rain.
" 7	77	51	29·00	28·81	Cloudy and fog.
" 8	76	52	28·95	29·21	Fog—Fine.
" 9	75	54	28·83	29·81	Fair.
" 10	80	55	28·80	28·65	Fair.
" 11	76	53	28·53	28·52	Rain.
" 12	77	55	28·00	27·70	Rain and cold.
" 13	70	59	28·74	28·51	Cloudy and cold.
" 14	72	57	28·71	28·76	Fair and cold.
" 15	76	54	28·79	29·05	Fair and cold.
" 16	76	55	29·10	28·81	Cloudy.
" 17	74	57	28·85	28·91	Cloudy.
" 18	76	50	28·87	28·81	Fair.
" 19	78	51	28·91	28·87	Cloudy.
" 20	78	52	28·95	28·70	Cloudy.
" 21	68	50	28·62	28·60	Rain.
" 22	78	51	28·75	28·76	Cloudy and cold.
" 23	79	49	28·73	28·56	Cloudy and cold.
" 24	70	47	28·59	28·70	Rain.
" 25	76	48	28·72	28·70	Rain and cold.
" 26	77	42	28·90	28·92	Cloudy.
" 27	69	43	29·00	28·91	Cloudy.
" 28	68	46	28·95	28·93	Rain.
" 29	68	44	28·77	28·55	Rain.
" 30	67	53	28·54	28·62	Rain.
" 31	75	50	28·73	28·42	Cloudy.
September 1	77	47	28·51	28·62	Rain.
" 2	76	46	28·79	28·85	Fine.
" 3	75	48	28·81	28·75	Rain.
" 4	73	46	28·79	28·85	Rain.
" 5	78	52	28·75	27·50	Rain and cold.
" 6	67	53	27·75	28·70	Rain and gales.
" 7	69	49	28·66	28·74	Fine.
" 8	68	49	28·73	28·79	Fine.
" 9	69	50	28·74	28·74	Fine.
" 10	70	56	28·90	28·79	Fine.
" 11	72	54	29·10	28·95	Fine.
" 12	76	54	28·90	29·00	Fine—Rain.
" 13	74	53	28·62	28·82	Rain and gales.
" 14	70	52	29·30	28·71	Rain and gales.
" 15	66	28	29·45	29·45	Fair and cold.
" 16	65	33	29·10	28·95	Cloudy and cold.
" 17	66	34	28·95	28·85	Cloudy and cold.
" 18	63	40	29·70	28·90	Fine—Rain.
" 19	64	41	29·21	29·00	Rain and gales.
" 20	64	40	28·50	28·85	Rain and gales.
" 21	66	39	29·10	28·55	Rain and gales.
" 22	66	41	28·45	28·30	Rain and snow.
" 23	57	30	28·91	28·90	Snow flurries.
" 24	56	27	29·25	29·10	Cloudy and cold.
" 25	57	26	29·20	29·15	Fine.
" 26	54	24	29·10	28·95	Snow flurries.
" 27	44	30	29·10	29·25	Rain and snow.
" 28	47	27	29·45	29·40	Cold and windy.
" 29	54	29	29·05	29·32	Fair and cold.
" 30	57	30	29·00	28·85	Fair and cold.
October 1	60	36	28·75	28·60	Cloudy and rain.
" 2	64	37	28·49	28·45	Fair and mild.
3	60	41	28·50	28·40	Cloudy and cold.

Date.	Temperature.		Barometer.		Remarks.
	Max.	Min.	A. M.	P. M.	
1912.	°	°	In.	In.	
October 4	61	40	28·50	28·57	Cold rain.
" 5	49	37	29·10	29·15	Cold rain.
" 6	47	31	29·15	29·00	Cloudy and cold.
" 7	51	34	28·70	28·70	Cloudy—Rain.
" 8	48	35	28·75	28·95	Rain and snow.
" 9	48	30	29·23	29·12	Cloudy and cold.
" 10	43	26	28·91	28·87	Cloudy and cold.
" 11	46	34	29·00	28·80	Fine.
" 12	47	33	29·15	29·10	Cloudy and gales.
" 13	54	24	28·75	28·60	Cloudy and cold.
" 14	55	27	28·82	28·89	Fair and cold.
" 15	50	32	29·10	28·95	Fair and mild.
" 16	46	34	29·00	28·70	Fair and mild
" 17	49	33	28·80	28·82	Cloudy and cold.
" 18	47	36	28·81	28·85	Light snow.
" 19	45	35	29·00	28·80	Fair.
" 20	41	33	28·75	28·55	Snow, 3 in.
" 21	41	28	28·70	28·90	Fair and cold.
" 22	40	27	29·15	29·00	Fair and cold.
" 23	38	27	28·32	28·82	Fair and milder.
" 24	39	28	28·41	28·63	
" 25	47	29	29·15	28·94	

Fine is intended to mean *Clear*.
Fair is intended to mean *Partly Cloudy*.

The following summary shows the highest and lowest readings and the average temperatures for each month together with the number of times the mercury fell below the freezing point:—

August—	
Highest reading on 10th	80°
Lowest reading on 26th	42°
Average maximum	73°.5
" minimum	49°.6
Number of times below 32°	None.
September—	
Highest reading on 5th	78°
Lowest reading on 26th	24°
Average maximum	62°.2
" minimum	40°.9
Number of times below 32°	9
October (1st to 25th)—	
Highest reading on 2nd	64°
Lowest reading on 13th	24°
Average maximum	48°.5
" minimum	32°.3
Number of times below 32°	11

TEMPERATURES, Pasquia District, year 1913.

Date.		Maximum.	Minimum.
		°	°
June	1	....	....
“	2	....	....
“	3	....	....
“	4	....	....
“	5	....	....
“	6	....	....
“	7	72	45
“	8	81	39
“	9	84	40
“	10	75	[illegible]
“	11	77	[illegible]
“	12	75	[illegible]
“	13	84	[illegible]
“	14	77	[illegible]
“	15	83	[illegible]
“	16	82	[illegible]
“	17	69	43
“	18	....	....
“	19	59	44
“	20	67	42
“	21	71	47
“	22	77	52
“	23	81	61
“	24	89	61
“	25	69	62
“	26	64	58
“	27	69	56
“	28	73	51
“	29	65	49
“	30	69	45
July	1	67	56
“	2	65	51
“	3	67	46
“	4	70	50
“	5	75	48
“	6	77	54
“	7	85	48
“	8	73	47
“	9	69	57
“	10	66	54
“	11	63	50
“	12	69	46
“	13	66	56
“	14	76	57
“	15	75	57
“	16	75	58
“	17	77	57
“	18	73	53
“	19	73	66
“	20	74	61
“	21	68	52
“	22	73	46
“	23	79	50
“	24	74	56
“	25	58	49
“	26	73	48
“	27	79	50
“	28	85	62
“	29	65	59
“	30	77	55
“	31	78	62
August	1	75	48
“	2	79	46
“	3	75	57
“	4	76	53
“	5	77	53
“	6	65	59
“	7	66	53
“	8	63	42
“	9		

TEMPERATURES, Pasquia District, year 1913—*Concluded.*

Date.	Maximum.	Minimum.
August 10	63	40
“ 11	65	48
“ 12	75	45
“ 13	80	57
“ 14	63	51
“ 15	73	59
“ 16	67	55
“ 17	67	42
“ 18	67	42
“ 19	77	59
“ 20	78	51
“ 21	73	55
“ 22	75	55
“ 23	69	53
“ 24	75	49
“ 25	71	61
“ 26	72	55
“ 27	71	55
“ 28	69	58
“ 29	79	54
“ 30	69	52
“ 31	60	50
September 1	63	55
“ 2	67	49
“ 3	71	51
“ 4	77	53
“ 5	80	61
“ 6	72	55
“ 7	63	51
“ 8	65	48
“ 9	66	61
“ 10	63	59
“ 11	60	56
“ 12	58	39
“ 13	60	41
“ 14	61	48
“ 15	62	44
“ 16	66	42
“ 17	74	50
“ 18	72	51
“ 19	49	40
“ 20		
“ 21		
“ 22	47	33
“ 23	38	36
“ 24	40	25
“ 25	50	28
“ 26	60	28
“ 27	71	40
“ 28	40	34
“ 29		
“ 30		

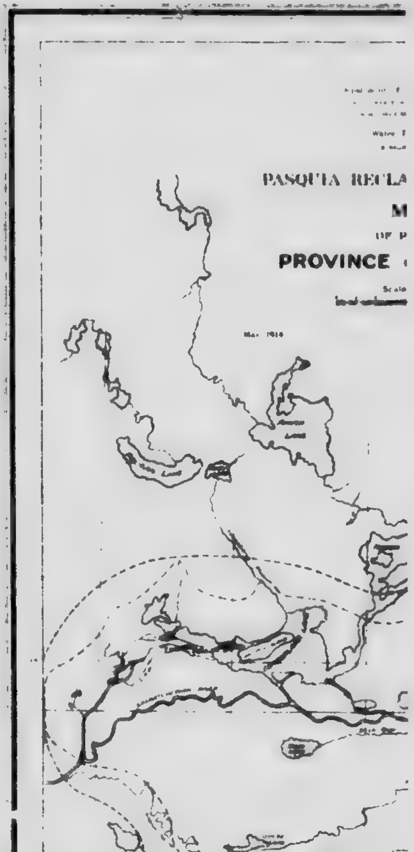
Month.	Days.	Average.
		°
June	22	Max. 71·6 Min. 51·6
uly	31	Max. 71·5 Min. 53·7
August	31	Max. 71·4 Min. 52·2
September	26	Max. 61·4 Min. 45·3

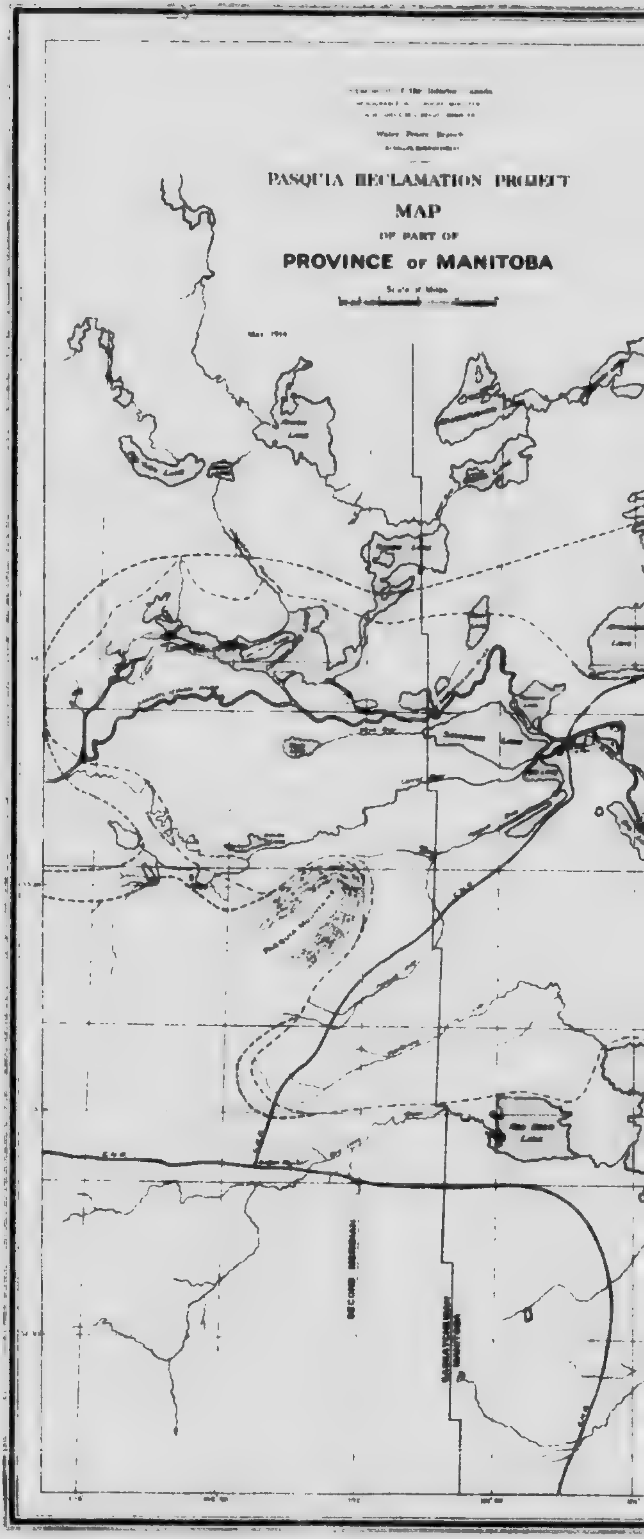
RUN-OFF.

River.	Area.	Month.	Monthly Mean.	Maximum per square mile.
	Sq. miles.		Cu. ft. per sec.	cu. ft. per sec. 1912.
Red	34,600	May	·068	·0849
"	"	June	·050	·0765
"	"	July	·033	·0552
"	"	August	·030	·0495
"	"	September	·032	·0698
"	"	October	·066	·1030
"	"	November	·046	·0445
"	"	December	·023	
				1913
"		January	·015	
"	"	February	·009	
"	"	March	·099	
"	"	April	·380	·752
"	"	May	·092	·151
"	"	June	·050	·0649
"	"	July	·038	·0510
"	"	August	·027	·0349
"	"	September	·033	·0466
"	"	October	·035	·0426
"	"	November		
"		December		
				1912.
Souris	22,500	October	·0035	
"	"	November	·0024	
"	"	December	·0009	
				1913
	"	January	·0004	
"	"	February	·0002	
"	"	March	·1044	
"	"	April	·1043	
"	"	May	·041	·064
"	"	June	·006	·0104
"	"	July	·0026	·0034
"	"	August	·0024	·0031
"	"	September	·0024	·00275
"	"	October	·0022	
"	"	November		
"	"	December		
Mossy	3,950	July	·039	
				1913
"	"	August	·031	·377
"	"	September	·023	·379
"	"	October	·018	·202
"	"	November		
"	"	December		
				1913.
Little Saskatchewan	1,250	January	·04	
" "	"	February	·05	
" "	"	March	·05	
" "	"	April	·74	1·55
" "	"	May	·42	·720
" "	"	June	·26	·389
" "	"	July	·30	·405
" "	"	August	·19	·38
" "	"	September	·049	·1008
" "	"	October	·058	·216
" "	"	November		
" "	"	December		
				1913
North Saskatchewan	149,500	January	·041	
" "	"	February	·033	
" "	"	March	·041	
" "	"	April	·229	
" "	"	May	·355	·419
" "	"	June	·337	·387
" "	"	July	·404	·426
" "	"	August	·388	·421
" "	"	September	·030	·368
" "	"	October	·017	
" "	"	November		
" "	"	December		

RUN-OFF.

River.	Area.	Month.	Monthly Mean.	Maximum per square mile.
	Sq. miles.		Cu. ft. per sec.	Cu. ft. per sec. 1913
Red Deer	4,900	July	·710	
"	"	August	·406	·514
"	"	September	·195	·296
"	"	October	·530	·127
"	"	November		
"	"	December		
				1913
Assiniboine	7,590	January	·022	
"	"	February	·021	
"	"	March	·026	
"	"	April	·632	
"	"	May	·596	·836
"	"	June	·245	·426
"	"	July	·445	·536
"	"	August	·334	·514
"	"	September	·145	·211
"	"	October	·093	·0982
"	"	November		
"	"	December		


Water
PASQUIA RECLA
M
OF P
PROVINCE
Scale
May 1914
SECOND MERIDIAN


Water Power Branch
PASQUIA RECLAMATION PROJECT
MAP
OF PART OF
PROVINCE OF MANITOBA
Scale of Miles
May 1914
SECOND MERIDIAN
SASKATCHEWAN
MANITOBA

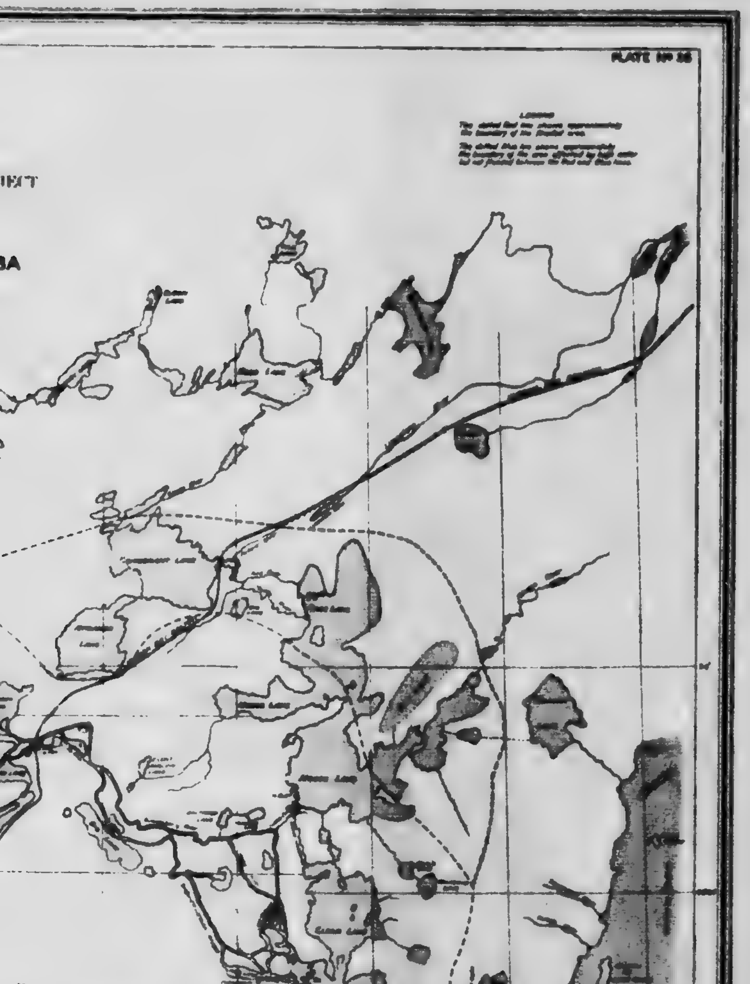
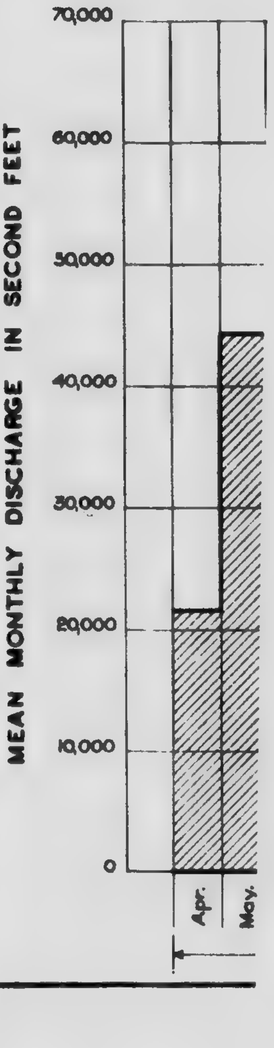


PLATE Nº 36
LEGEND
BA
LAKE


MEAN MONTHLY DISCHARGE IN SECOND FEET
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Apr.
May.

DIA

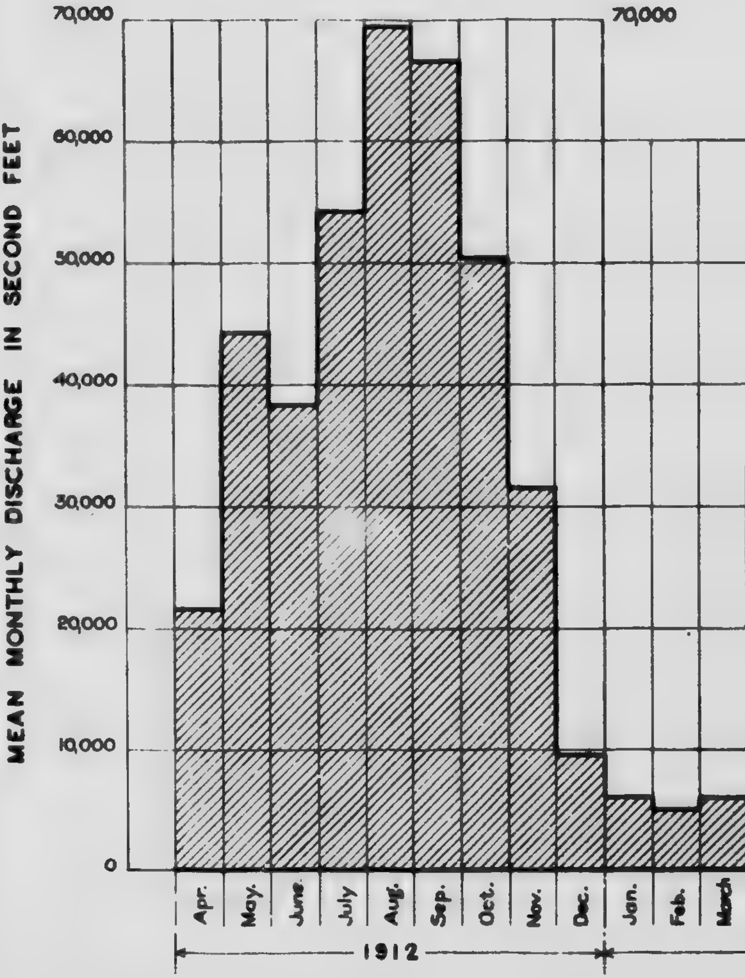

MEAN MONTHLY DISCHARGE IN SECOND FEET
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
70,000
Apr.
May.
June.
July
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
Feb.
March
1912

PLATE Nº 37.

WATER POWER BRANCH.

J. B. Challies, Superintendent.

SASKATCHEWAN RIVER.

DIAGRAM SHEWING MEAN MONTHLY DISCHARGE FROM APR. 1912 TO MAR. 1914.

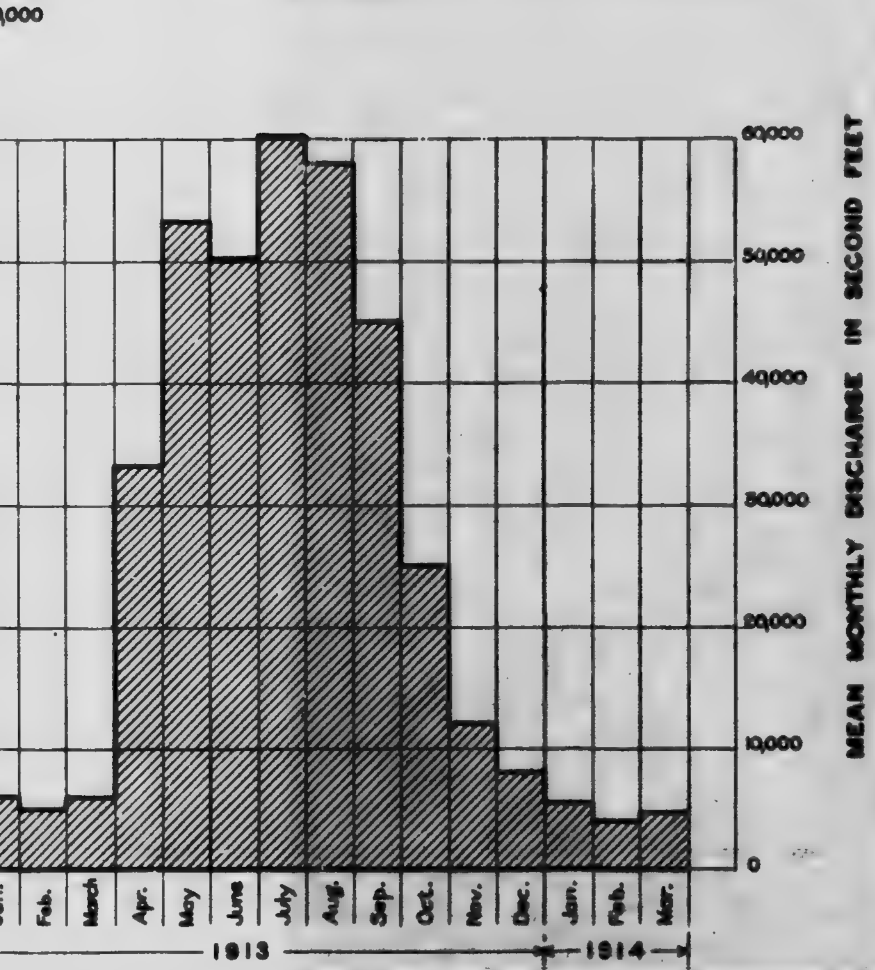
at

LE PAS, MANITOBA.

To accompany report on PASQUIA RECLAMATION PROJECT

BY THOS. H. DUNN, C. E.

Thos H Dunn Chief Engineer of Reclamation.



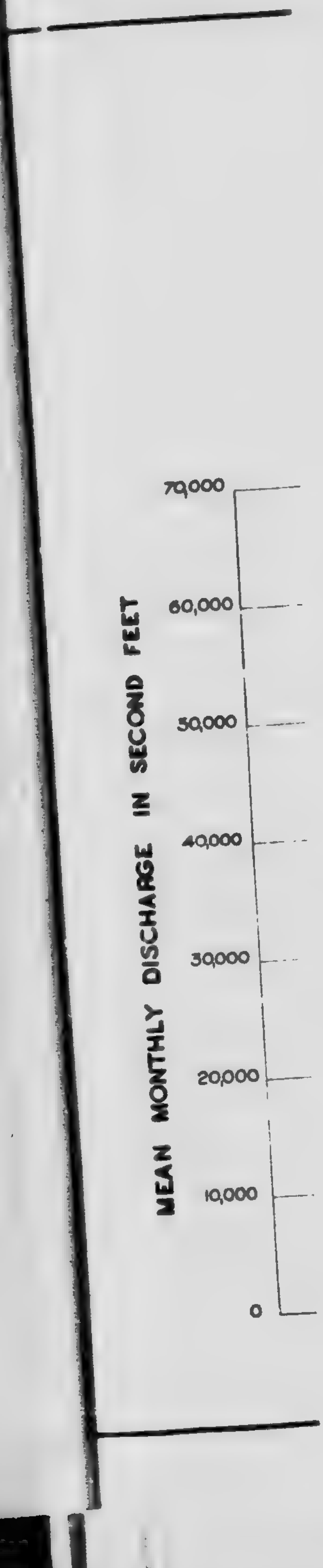

MEAN MONTHLY DISCHARGE IN SECOND FEET
70,000
60,000
50,000
40,000
30,000
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DIAGRAM SHEW

To acco

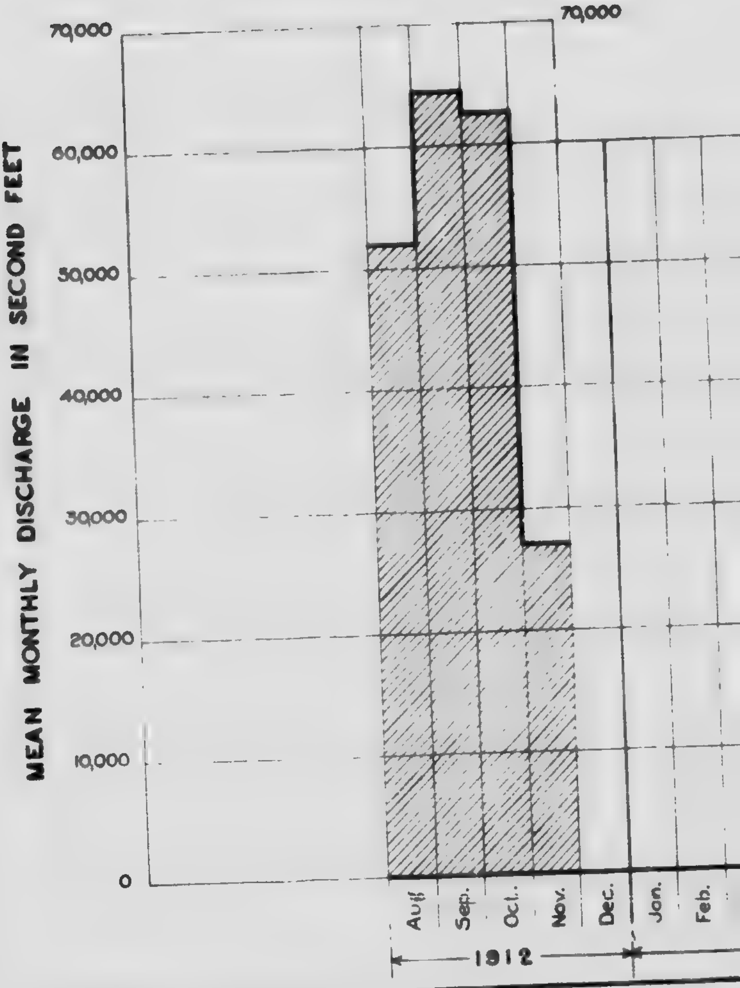


PLATE Nº 38

WATER POWER BRANCH.

J. B. Challies, Superintendent.

SASKATCHEWAN RIVER

AGRAM SHEWING MEAN MONTHLY DISCHARGE FROM AUG. 1912 TO NOV. 1913.

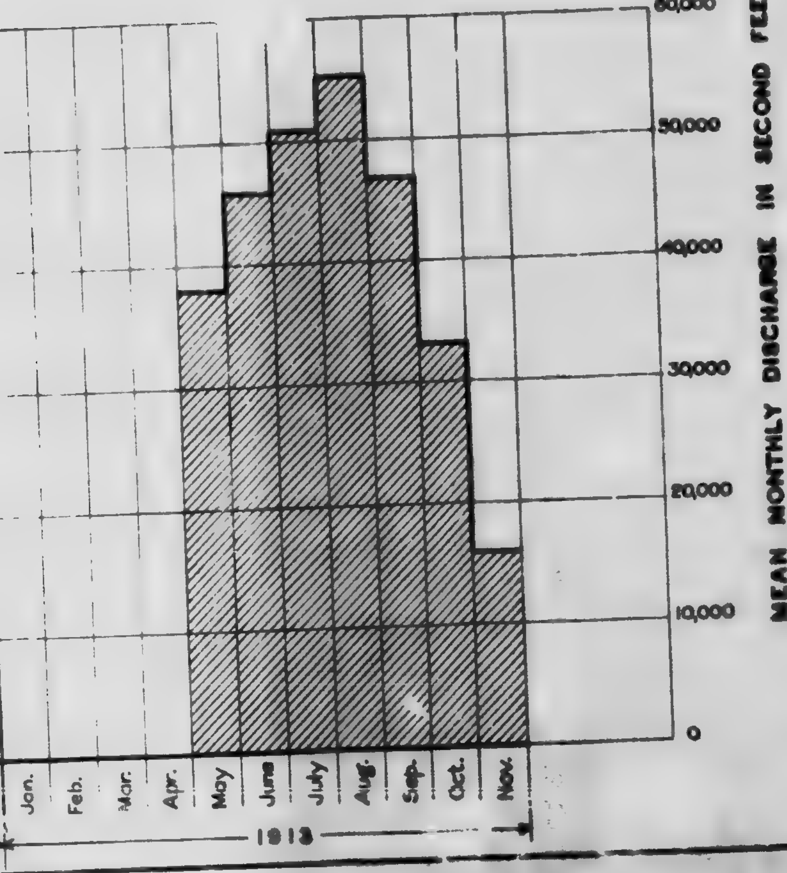
at

GRAND RAPIDS

To accompany report on PASQUIA RECLAMATION PROJECT

BY THOS. H. DUNN, C. E.

Thos. H. Dunn, Chief Engineer of Reclamation.



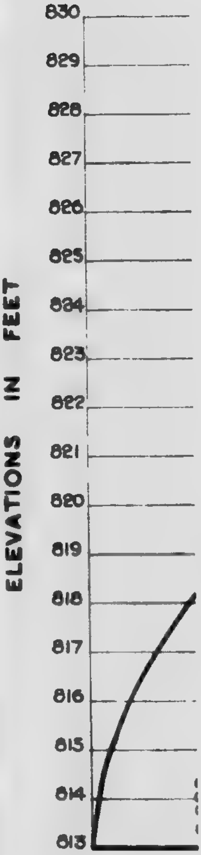
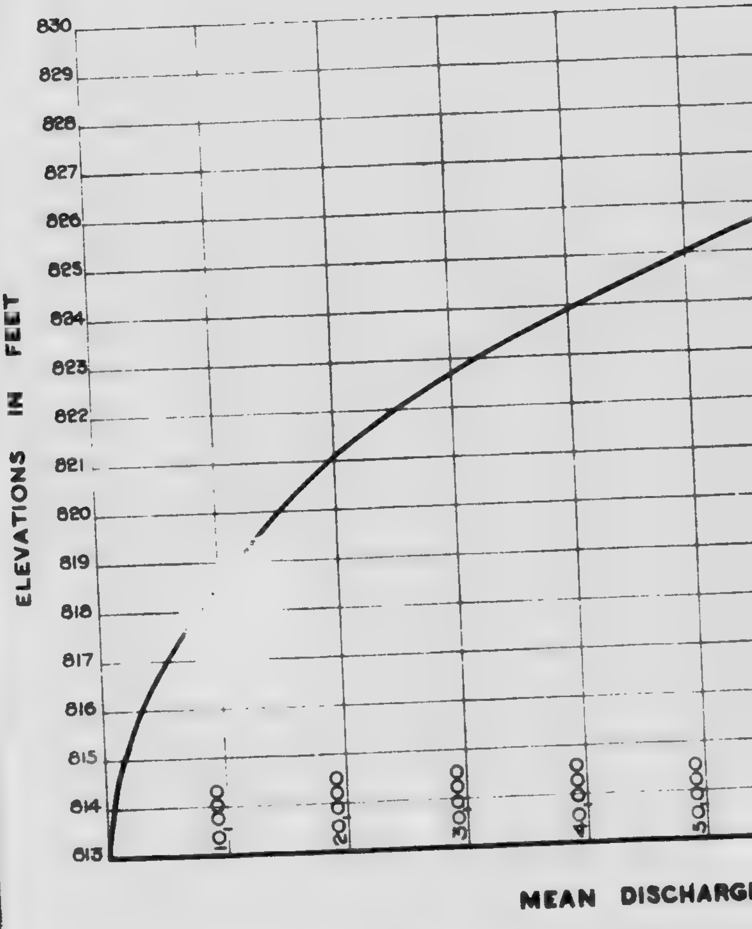

ELEVATIONS IN FEET
830
829
828
827
826
825
824
823
822
821
820
819
818
817
816
815
814
813

DIAGRAM S

To



ELEVATIONS IN FEET
830
829
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826
825
824
823
822
821
820
819
818
817
816
815
814
813
10,000
20,000
30,000
40,000
50,000
MEAN DISCHARG

PLATE Nº 39.

WATER POWER BRANCH.

J. B. Challies, Superintendent.

SASKATCHEWAN RIVER

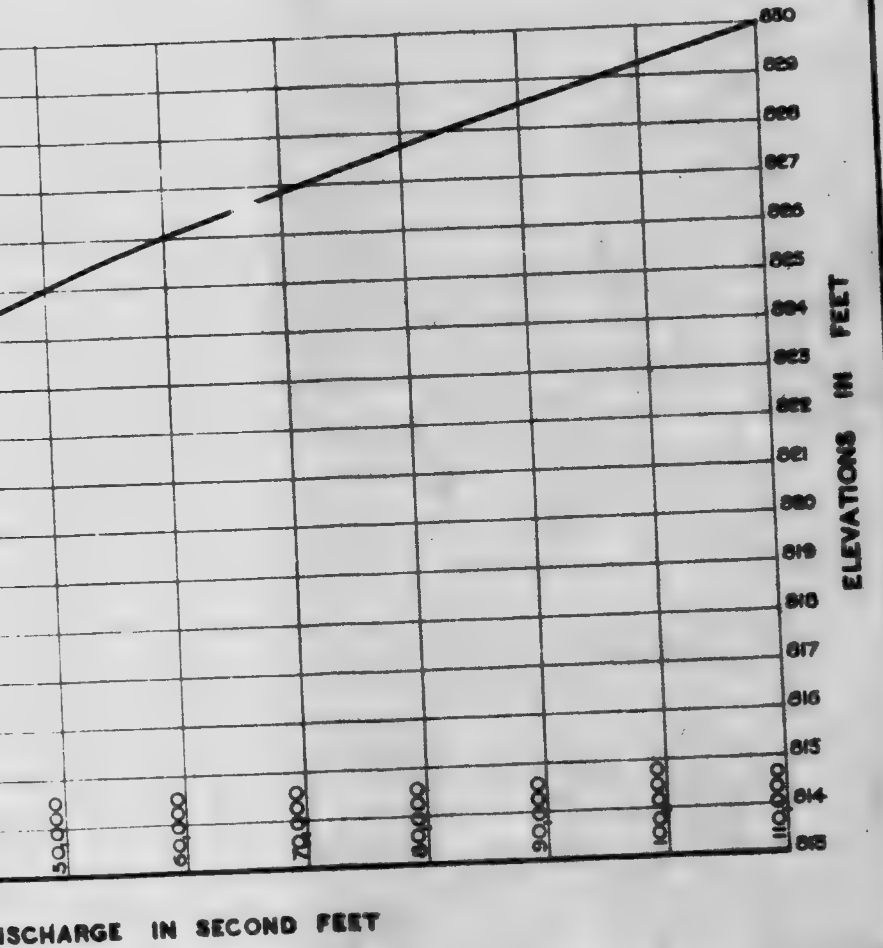
CEDAR LAKE TO CROSS LAKE

DIAGRAM SHEWING COMBINED DISCHARGE CURVE OF HIGH & LOW LEVEL CHANNELS.

To accompany report on PASQUIA RECLAMATION PROJECT

BY THOS. H. DUNN, C. E.

Thos H Dunn Chief Engineer of Reclamation.



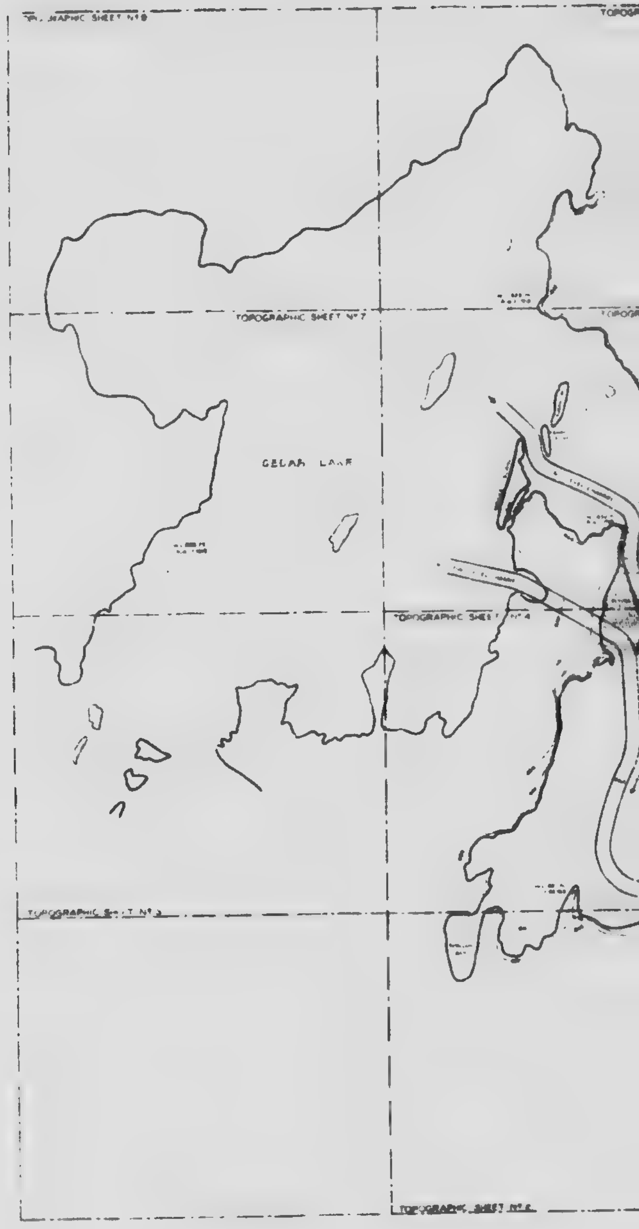
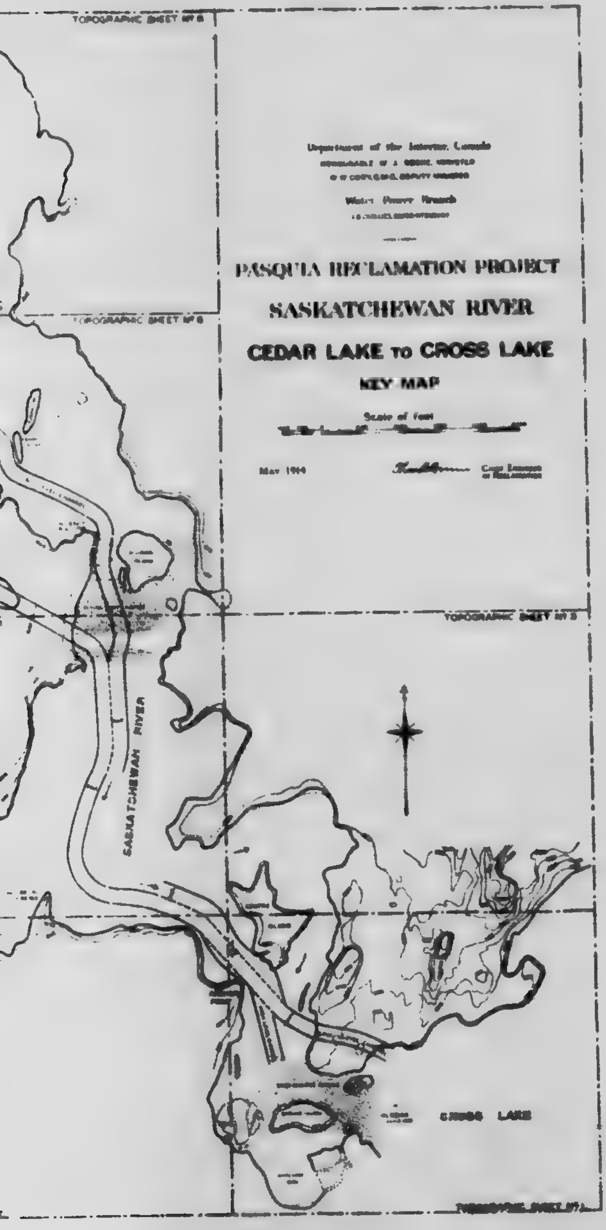

TOPOGRAPHIC SHEET No 8
TOPOGRAPHIC SHEET No 7
CEDAR LAKE
TOPOGRAPHIC SHEET No 4
TOPOGRAPHIC SHEET No 3
TOPOGRAPHIC SHEET No 2

PLATE No 40


Department of the Interior, Canada

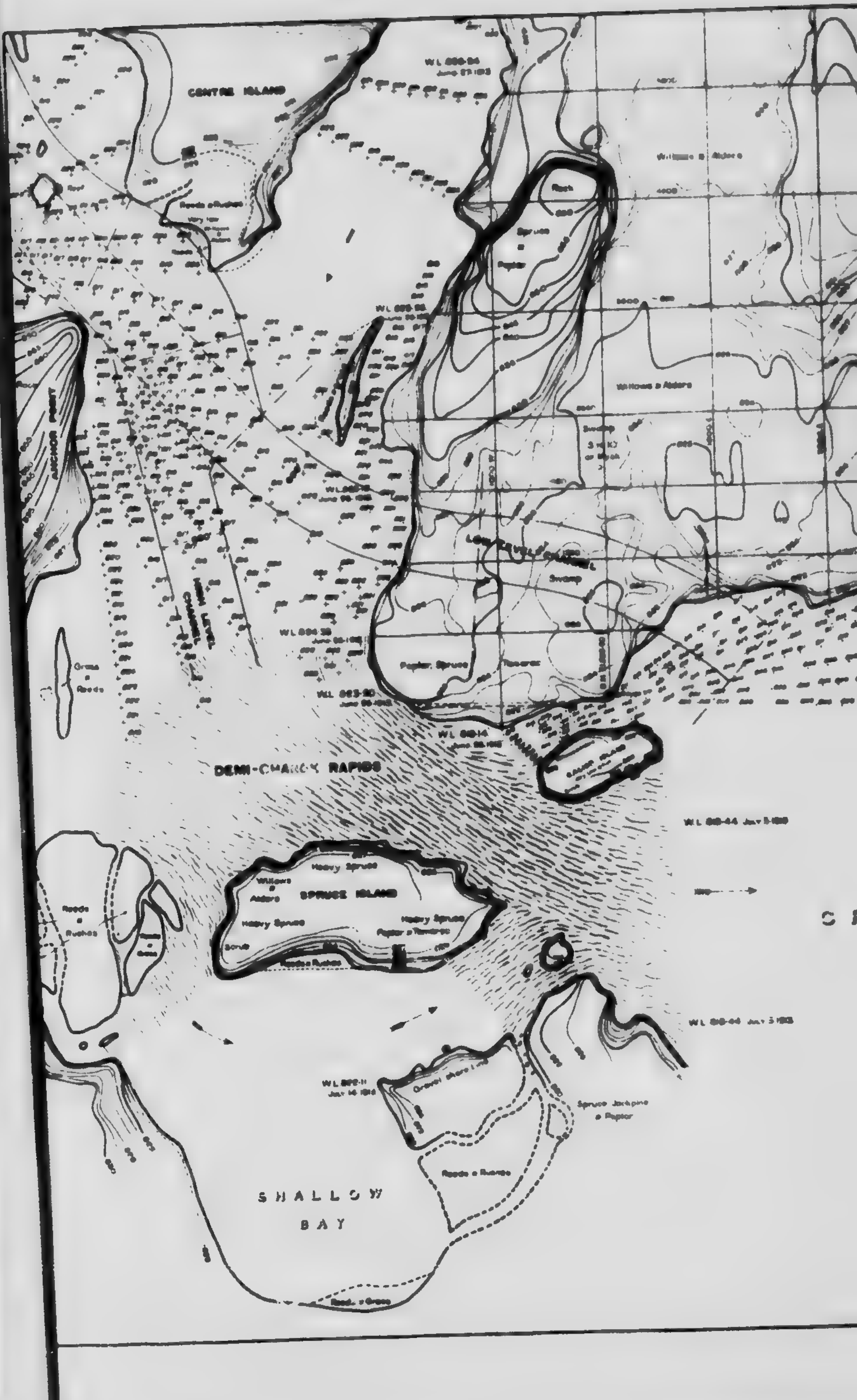
Water Power Branch

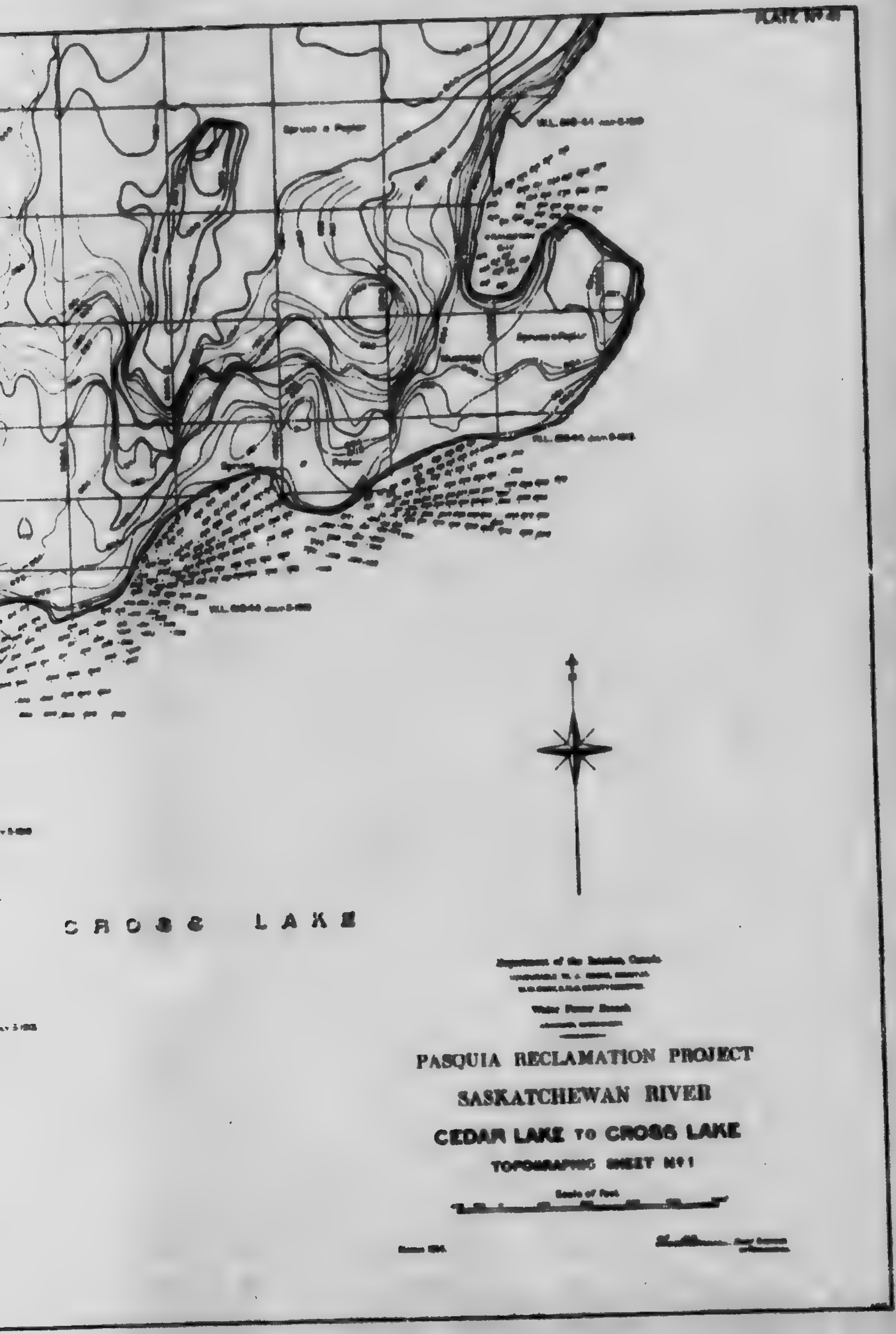
PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO CROSS LAKE
KEY MAP

Scale of Feet

May 1914

Chief Engineer of Reclamation


CENTRE ISLAND
ANCHOR POINT
Rock
Spruce
&
Poplar
Willows & Alders
Swamp
Swamp
Poplar, Spruce
DEMI-CHARGE RAPIDS
SPRUCE ISLAND
Heavy Spruce
Willows
&
Alders
Heavy Spruce
Heavy Spruce
Poplar & Tamarac
Scrub
Reeds & Rushes
Reeds
&
Rushes
Grass
&
Reeds
Gravel shore Line
Spruce Jackpine
& Poplar
Reeds & Rushes
SHALLOW
BAY
Reeds & Grass
C



Department of the Interior, Canada

Water Power Branch

PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO CROSS LAKE
TOPOGRAPHIC SHEET No 1

Scale of Feet

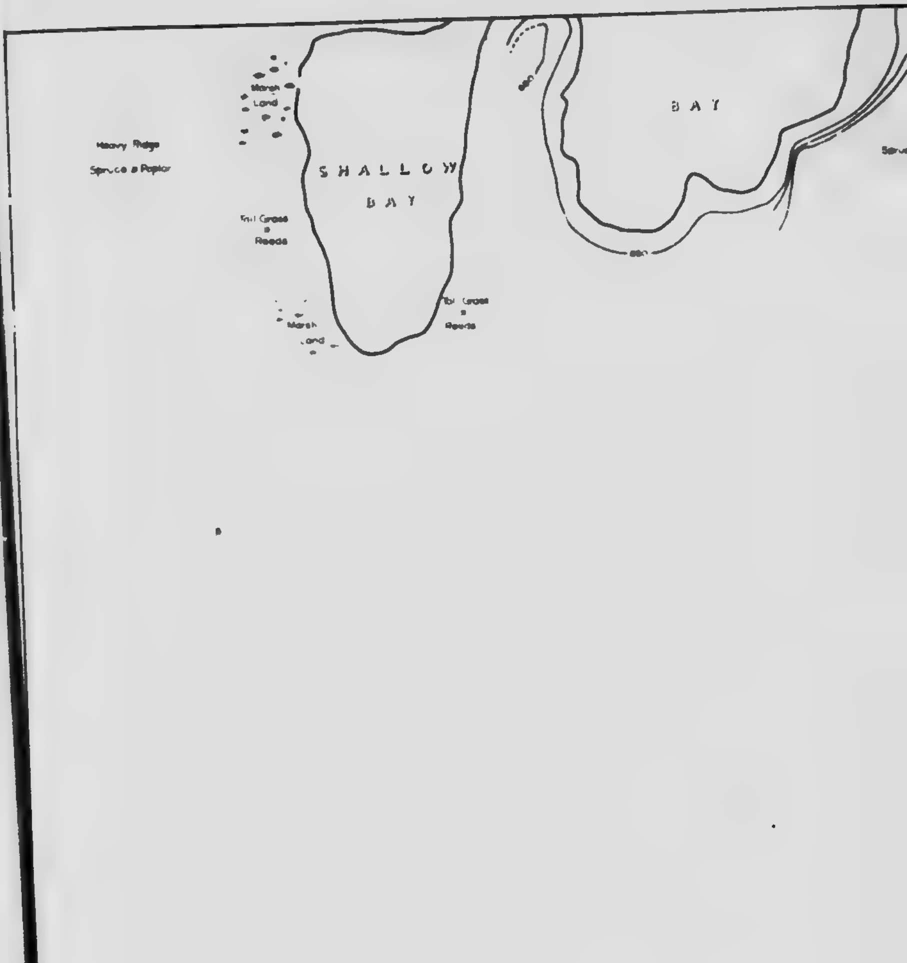
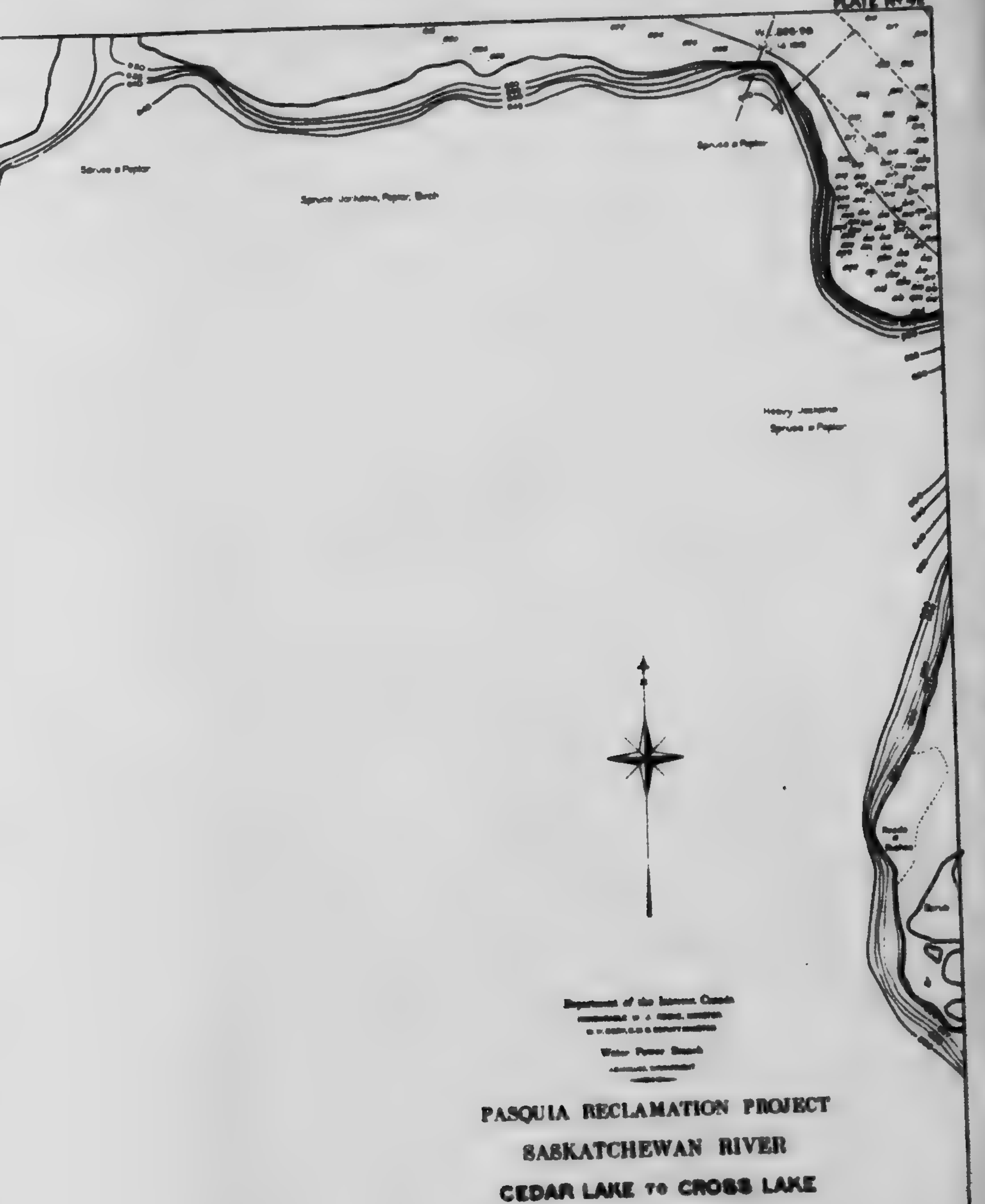

Heavy Ridge
Spruce & Poplar
Marsh Land
SHALLOW BAY
Tall Grass & Reeds
Marsh Land
Tall Grass & Reeds
880
BAY
880
Spru

PLATE No 42



Department of the Interior Canada

Water Power Branch

PASQUIA RECLAMATION PROJECT

SASKATCHEWAN RIVER

CEDAR LAKE TO CROSS LAKE

TOPOGRAPHIC SHEET No 2

Scale of Feet

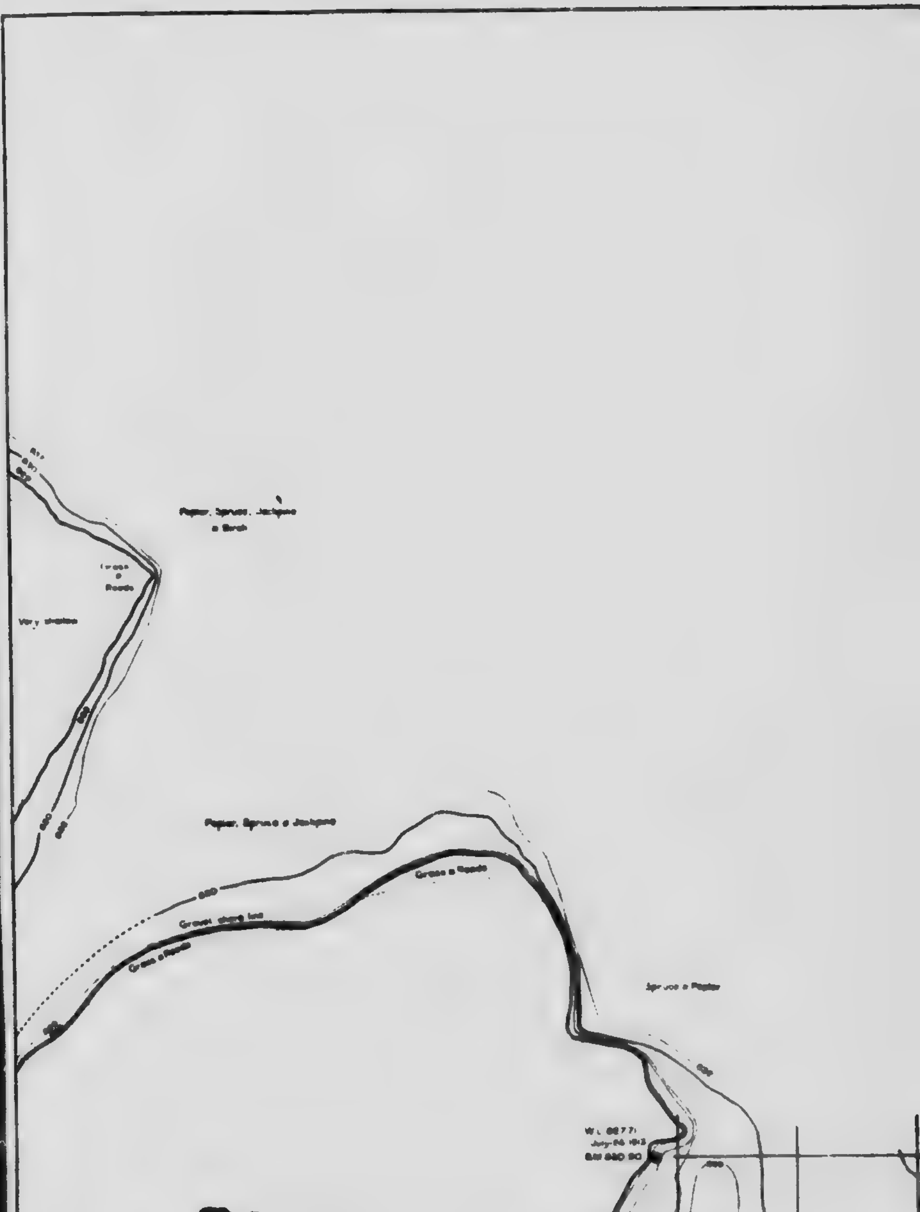
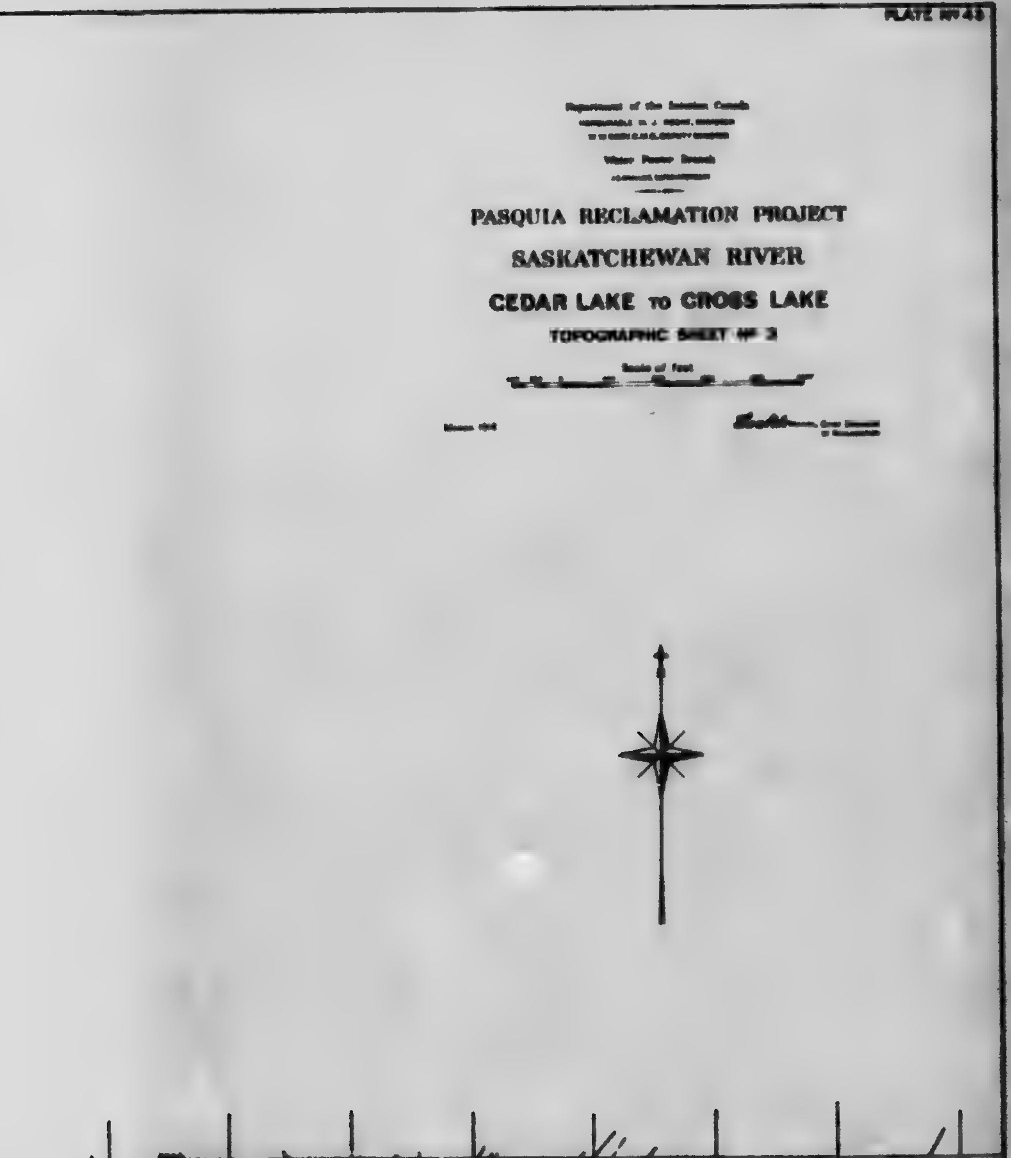
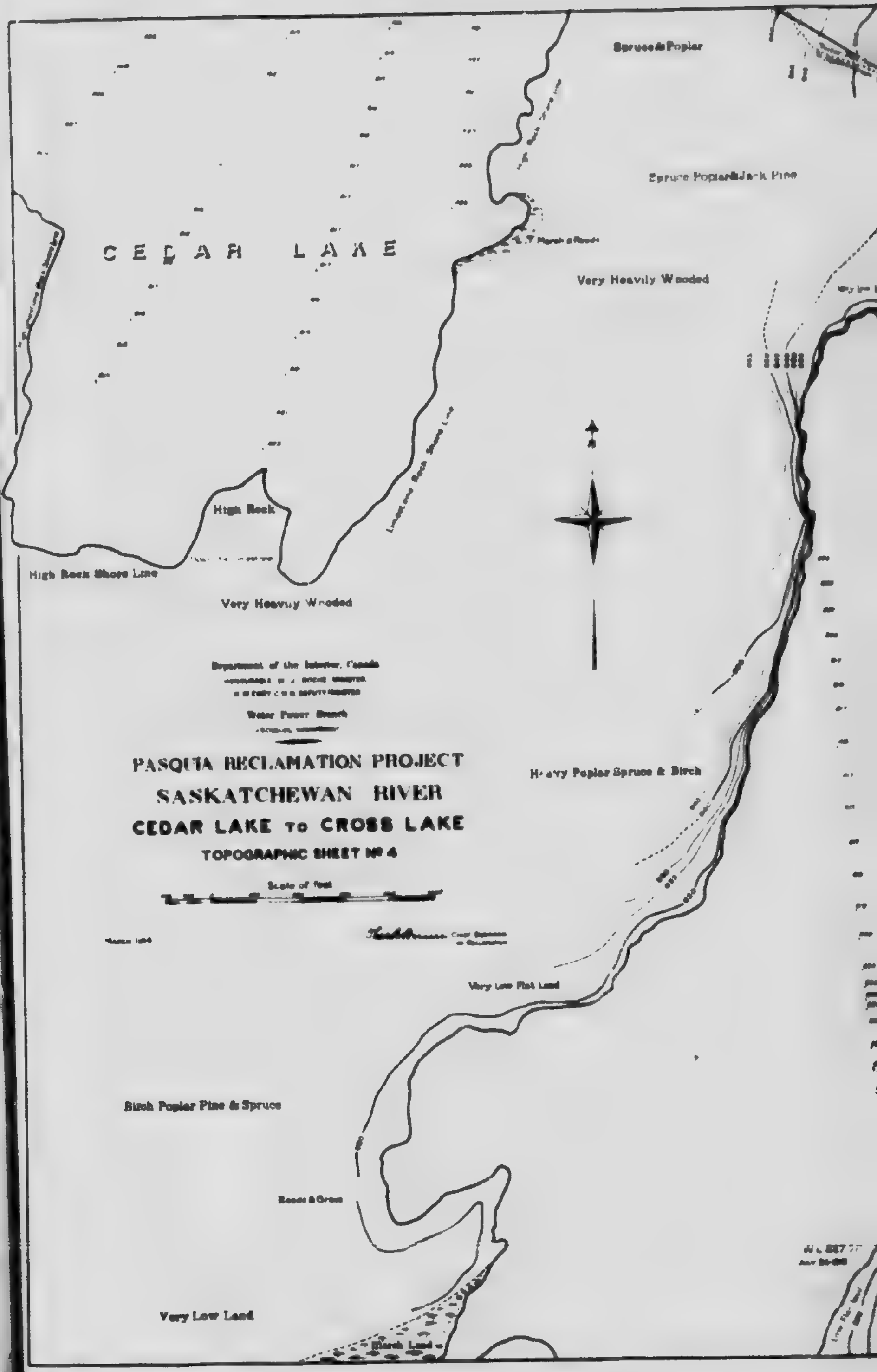

Poplar, Spruce, Jackpine
& Birch
Grass
&
Reeds
Very shallow
Poplar, Spruce & Jackpine
Grass & Reeds
Gravel shore line
Grass & Reeds
Spruce & Poplar
Heavy Spruce
& Poplar
CENTRE ISLAND

PLATE Nº 43

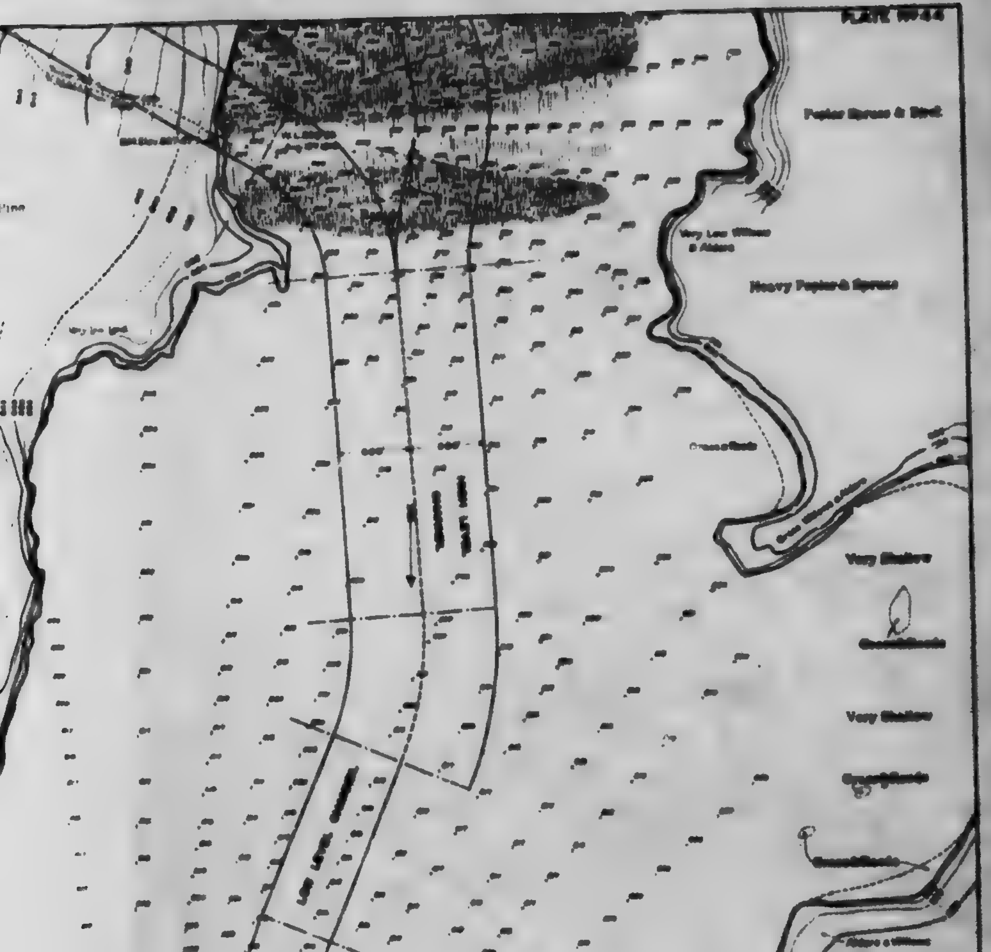

Department of the Interior Canada
Water Power Branch
PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO CROSS LAKE
TOPOGRAPHIC SHEET Nº 2
Scale of Feet
Heavy Spruce
Poplar, Tamarac
Heavy Spruce
Poplar, Tamarac

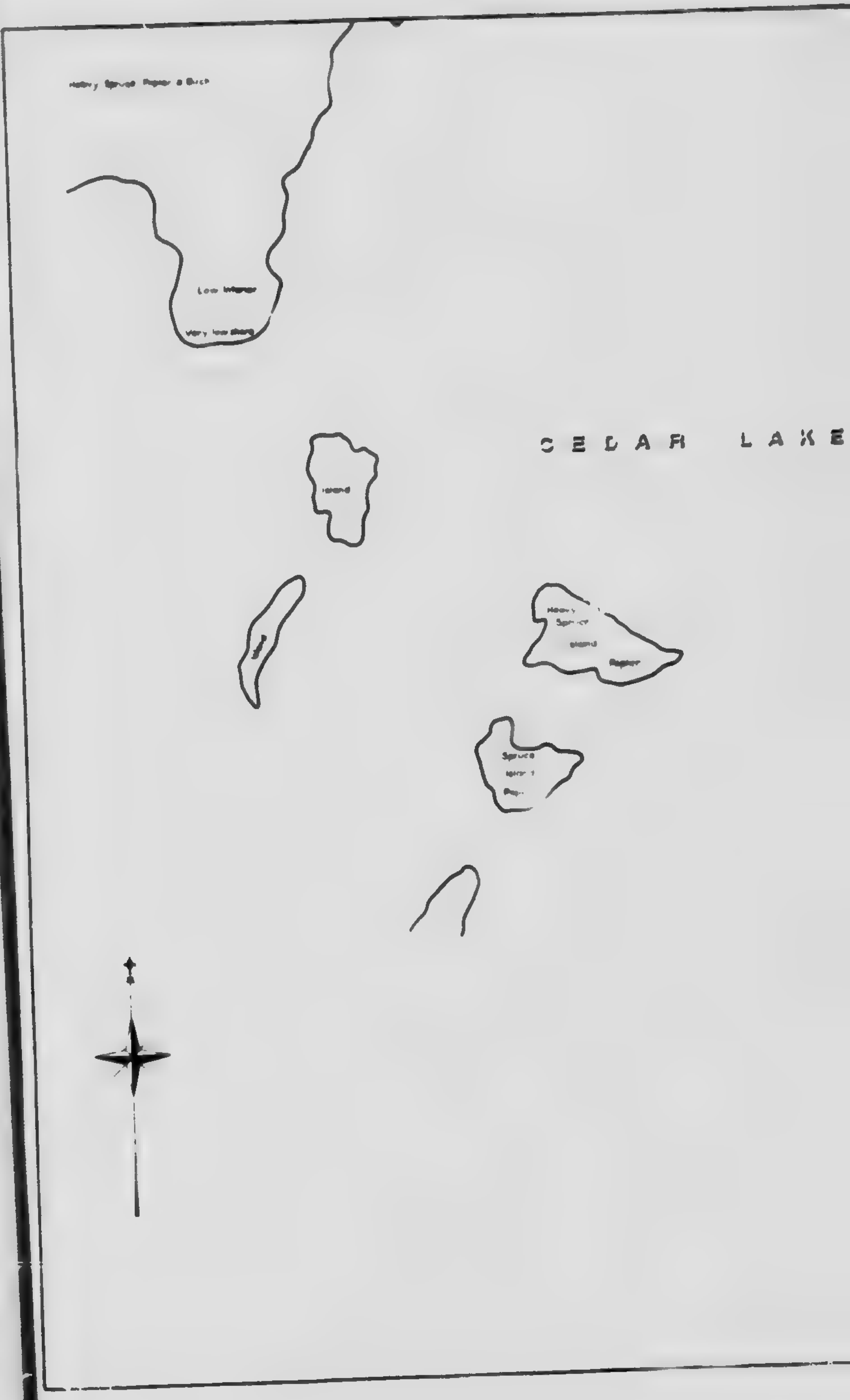


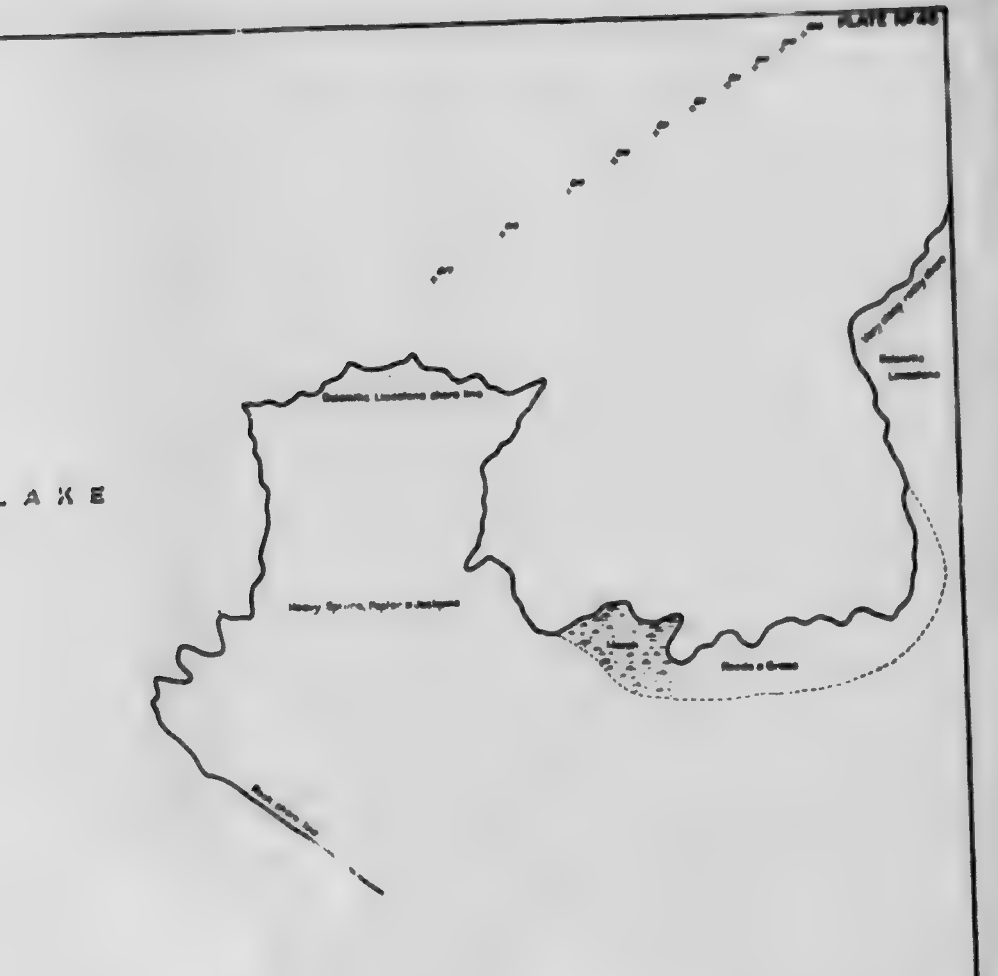
Department of the Interior, Canada
[illegible]
[illegible]
Water Power Branch
[illegible]

PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO CROSS LAKE
TOPOGRAPHIC SHEET Nº 4

Scale of Feet


Poplar Spruce & Birch
Very Low Willows & Alders
Heavy Poplar & Spruce
Very Shallow
Very Shallow
Poplar & Spruce
Low Level Channel
High Level Channel


Heavy Spruce Poplar & Birch
Low Interior
Very low shore
CEDAR LAKE
Island
Island
Heavy
Spruce
Island
Poplar
Spruce
Island
Pop



Department of the Interior Canada
[illegible]
[illegible]

Water Power Branch
[illegible]

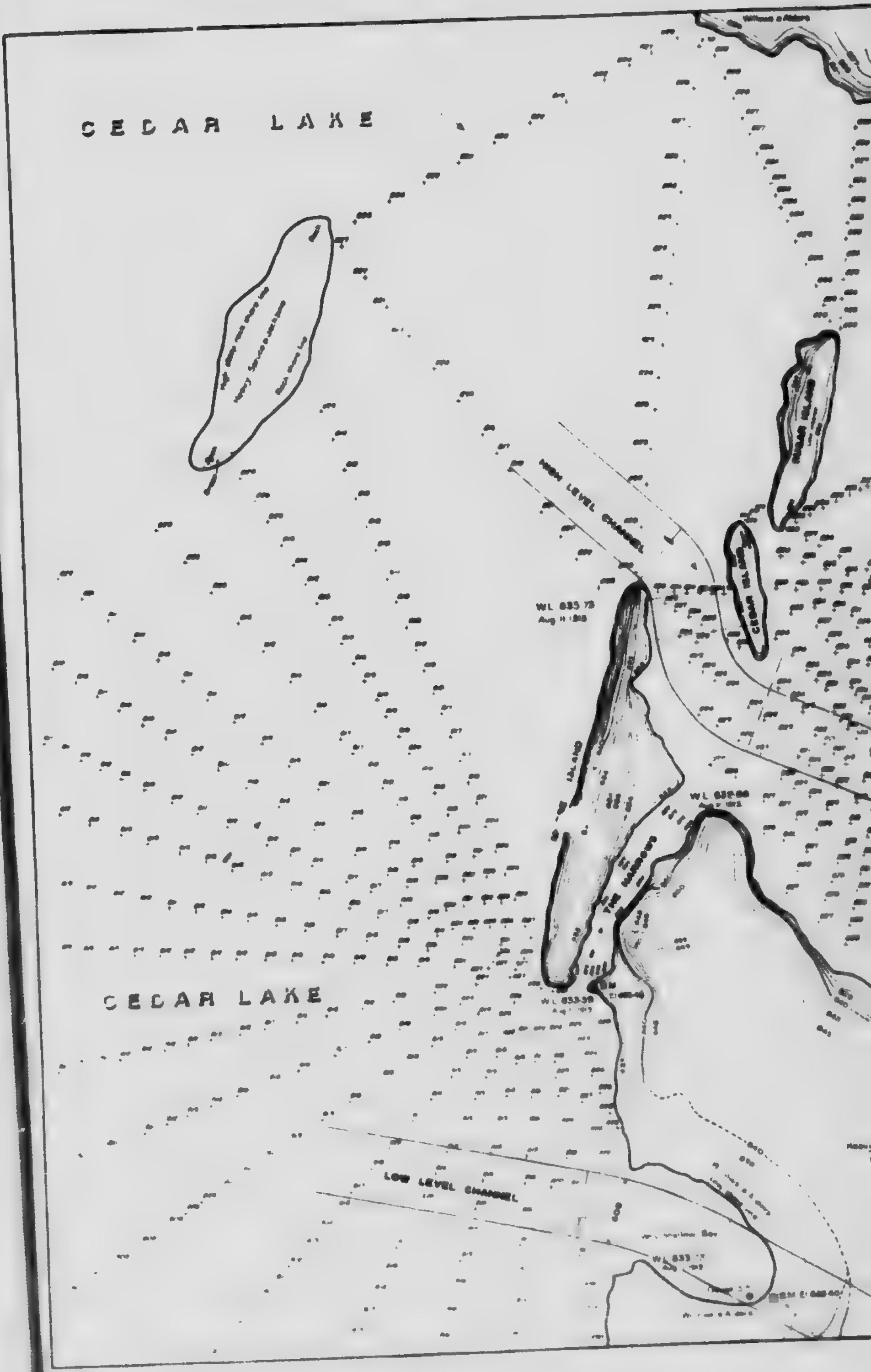
PASQUIA RECLAMATION PROJECT

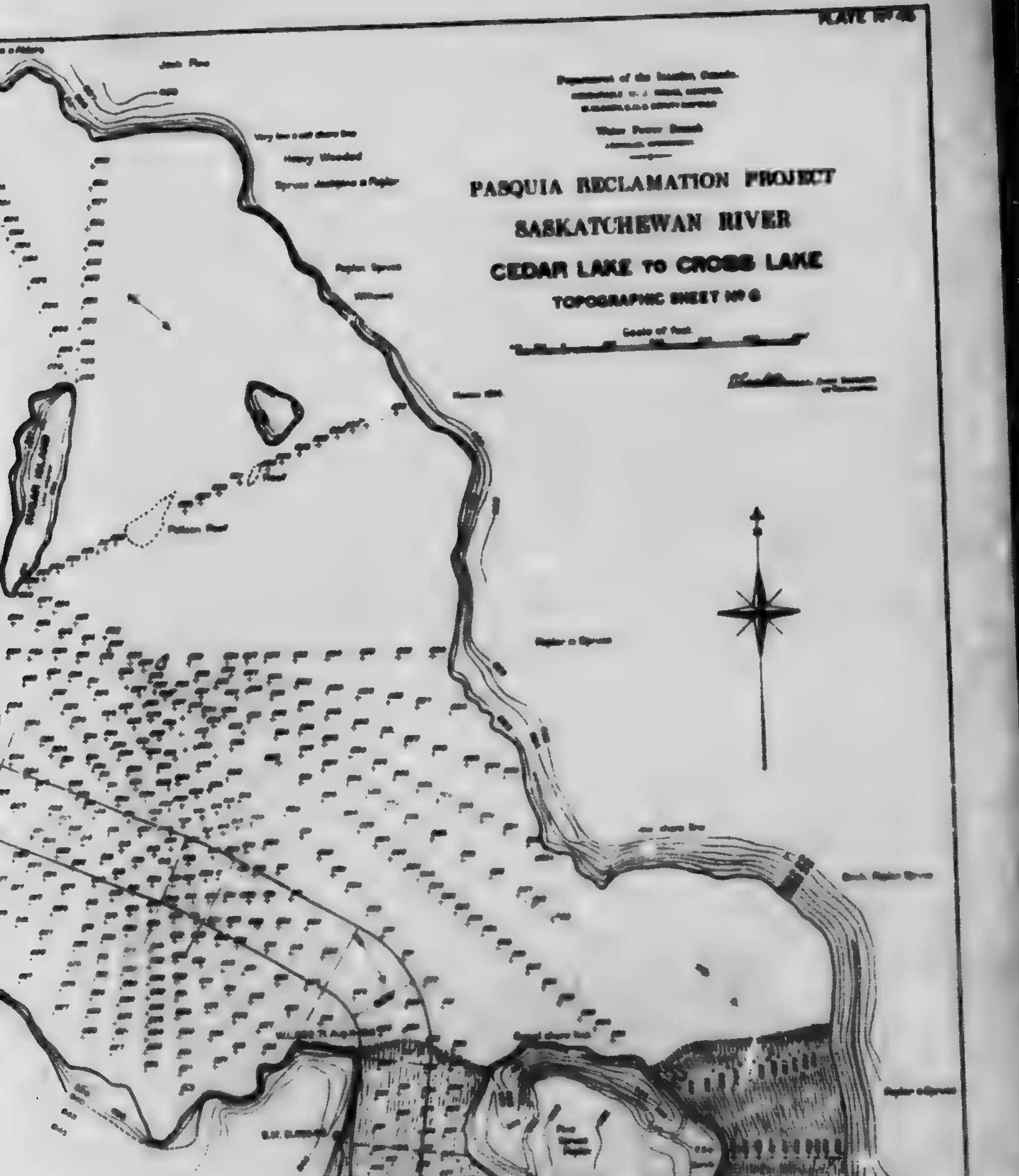
SASKATCHEWAN RIVER

CEDAR LAKE TO CROSS LAKE

TOPOGRAPHIC SHEET Nº 6

Scale of Feet.


CEDAR LAKE
HIGH LEVEL CHANNEL
WL 833 73
ISLAND
CEDAR ISLAND
THE NARROWS
WL 833.39
CEDAR LAKE
LOW LEVEL CHANNEL
WL 833

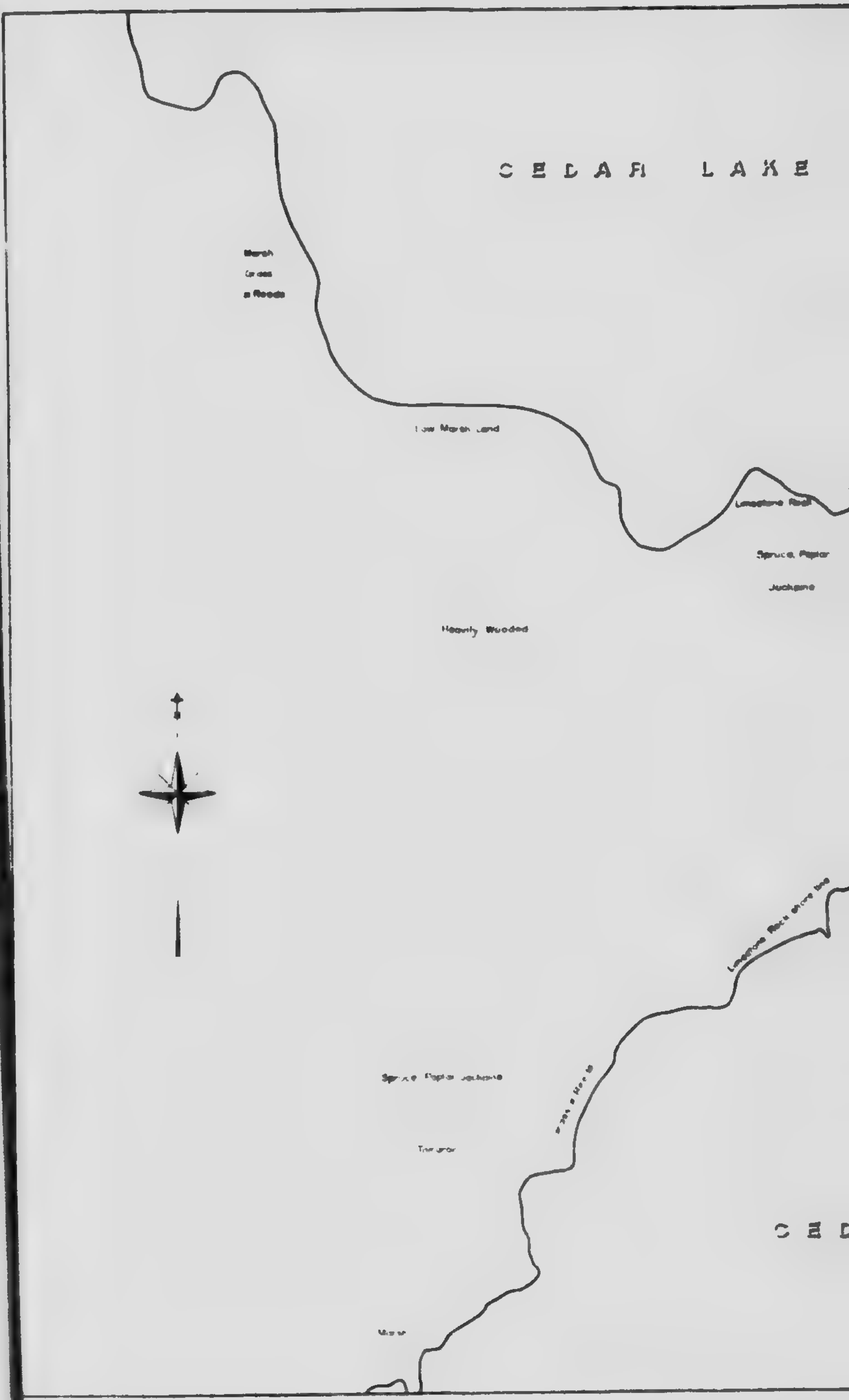


PASQUIA RECLAMATION PROJECT

SASKATCHEWAN RIVER

CEDAR LAKE TO CROSS LAKE

TOPOGRAPHIC SHEET Nº 6


CEDAR LAKE
Marsh
Grass
& Reeds
Low Marsh Land
Limestone Rock
Spruce, Poplar
Jackpine
Heavily Wooded
Limestone Rock shore line
Spruce Poplar Jackpine
Grass & Reeds
Tamarac
Marsh
CED

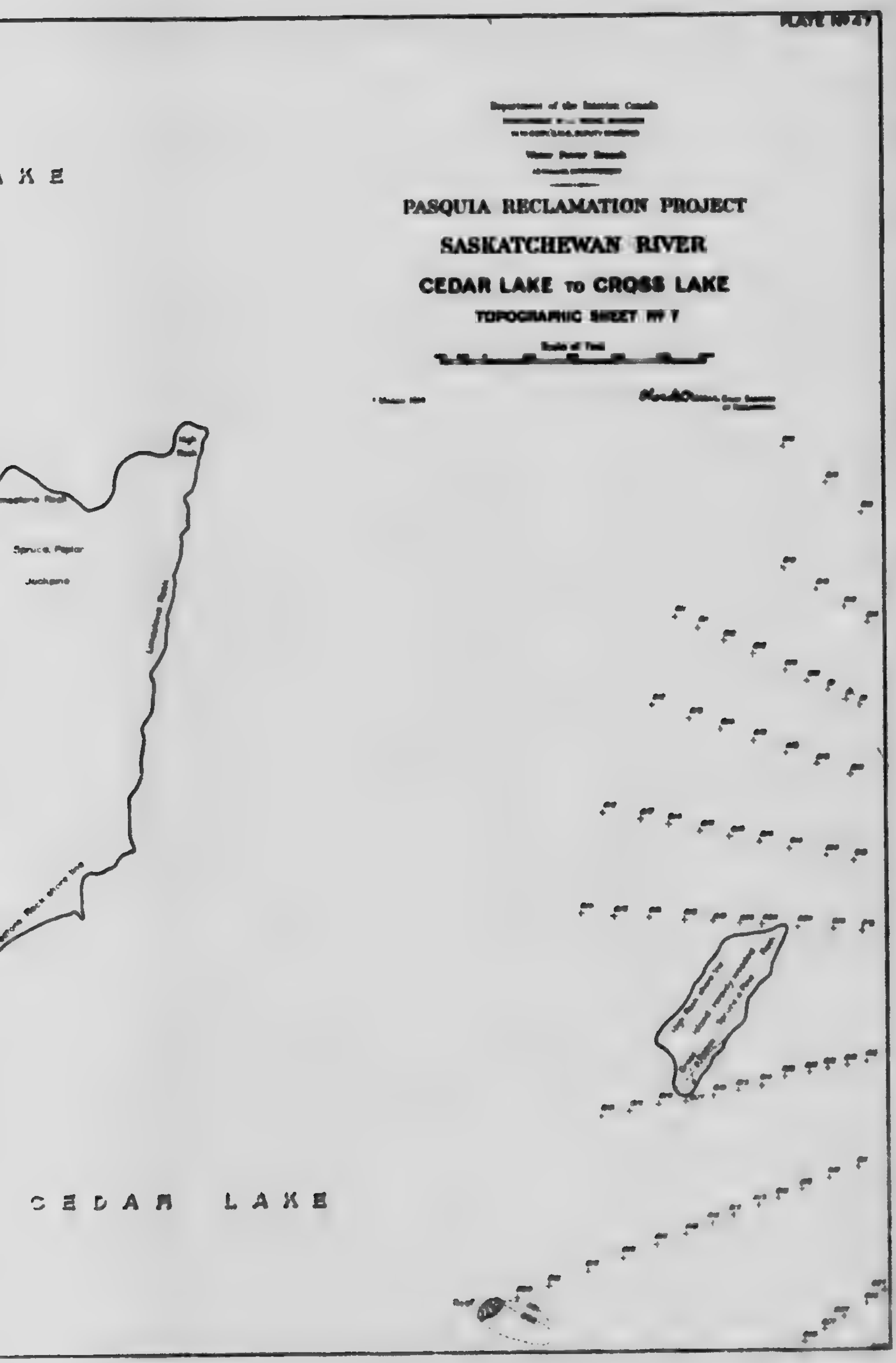


PLATE Nº 47
Department of the Interior Canada
Water Power Branch
PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO CROSS LAKE
TOPOGRAPHIC SHEET Nº 7
Scale of Feet
AKE
Spruce, Poplar
Jackpine
CEDAR LAKE
Reef

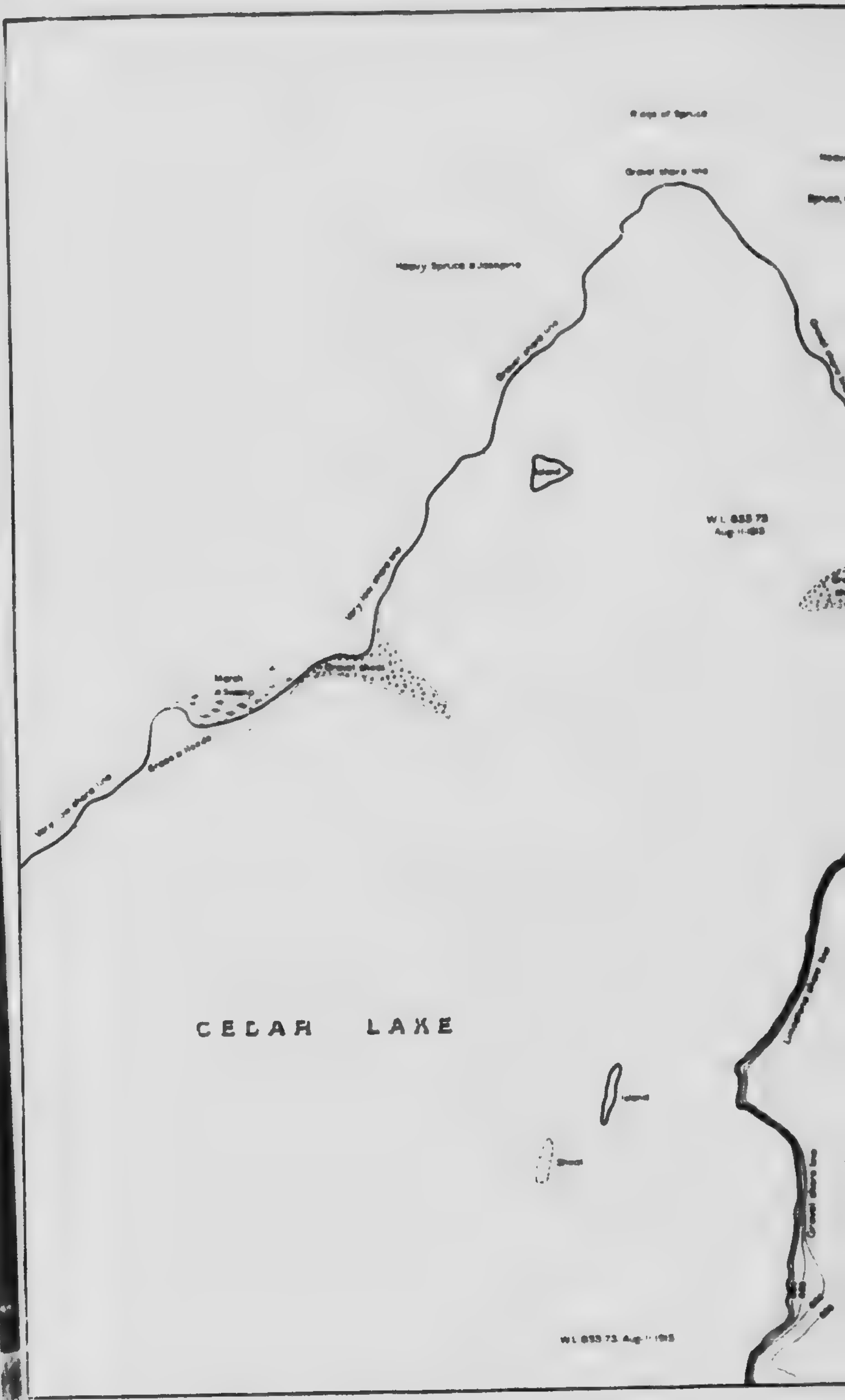
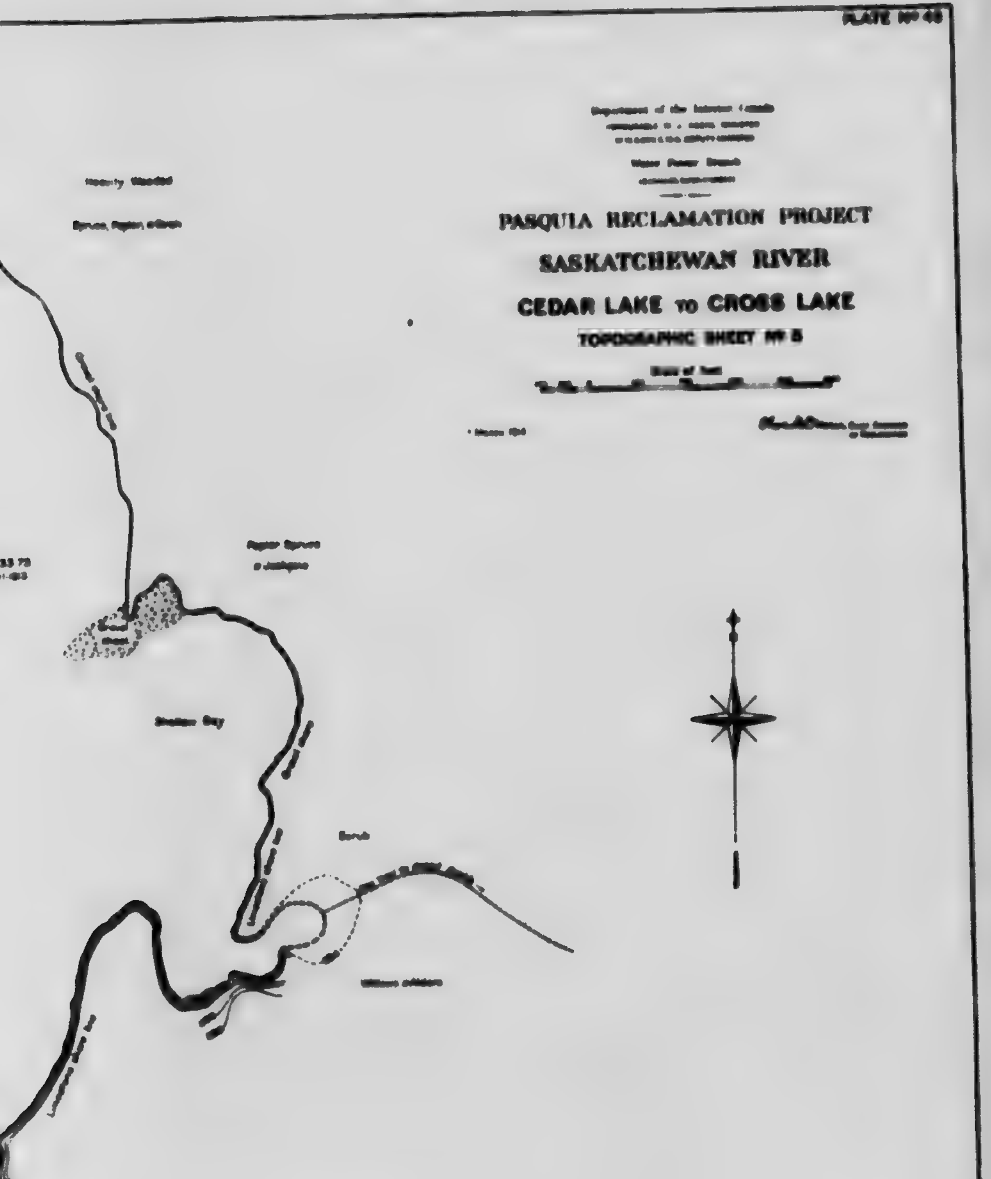

Ridge of Spruce
Gravel shore line
Heavy Spruce & Jackpine
Gravel shore line
Island
W.L. 833.73
Aug 11 1915
Very low shore line
Marsh
& Swamp
Gravel Shoal
Grass & Reeds
Very low shore line
CEDAR LAKE
Island
Shoal
Limestone shore line
Gravel shore line
W.L. 833.73 Aug 11 1915

PLATE Nº 48



Department of the Interior Canada

Water Power Branch

PASQUIA RECLAMATION PROJECT

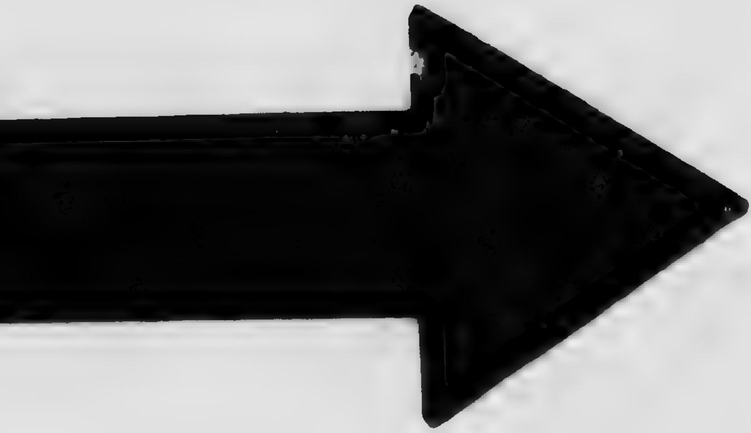
SASKATCHEWAN RIVER

CEDAR LAKE TO CROSS LAKE

TOPOGRAPHIC SHEET Nº 5

Scale of Feet

[redacted]



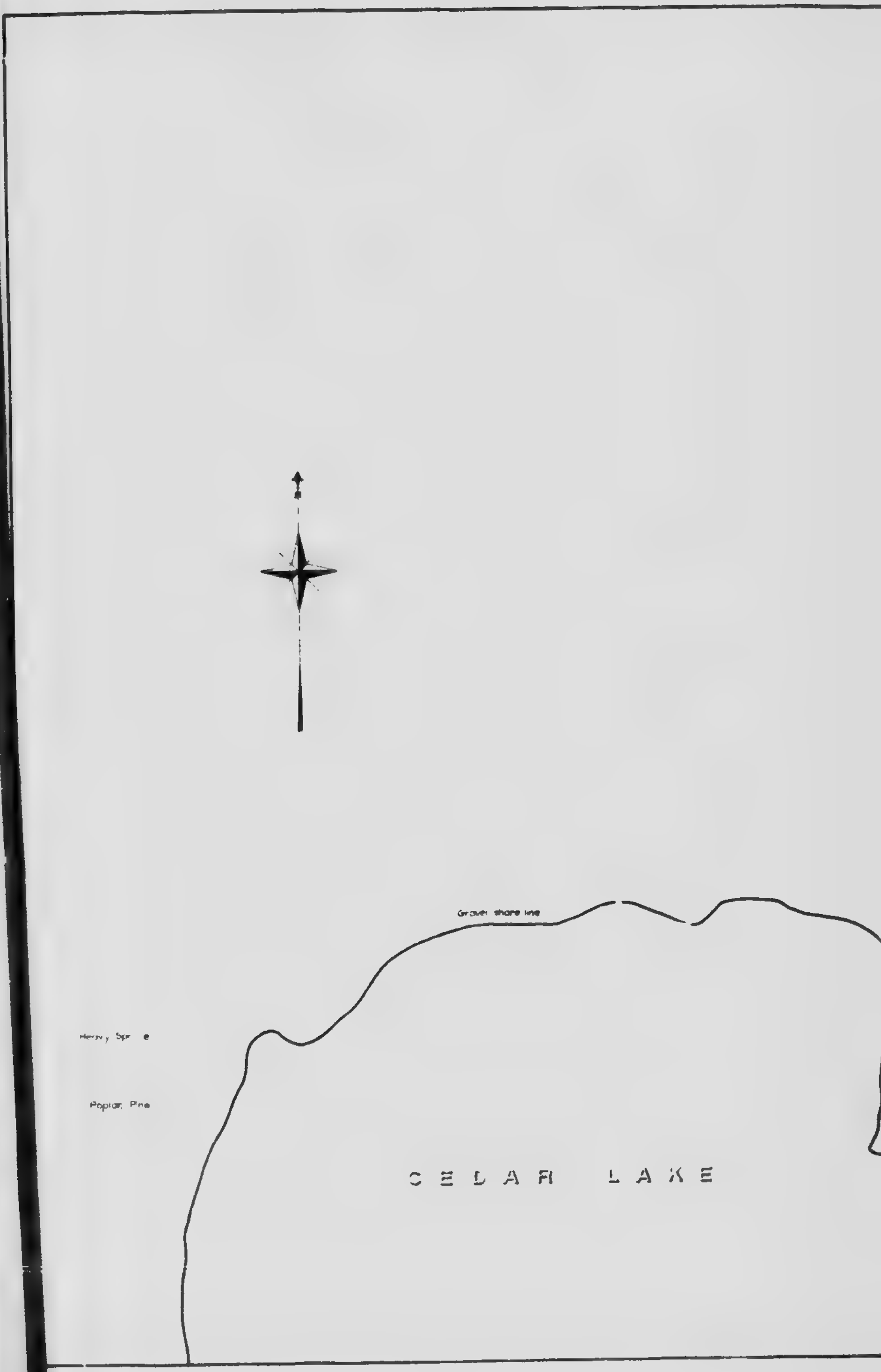
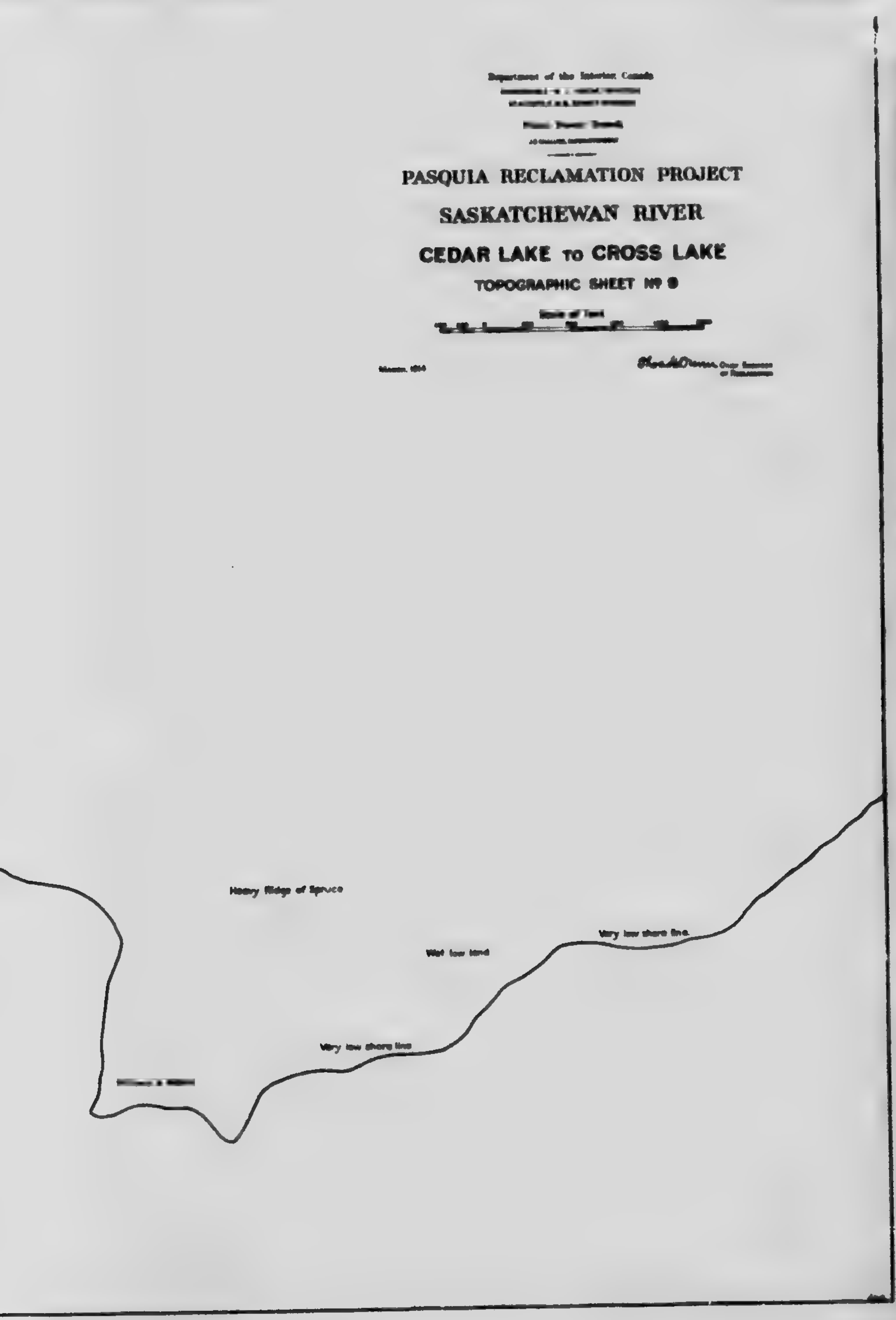

Gravel shore line
Heavy Spruce
Poplar, Pine
CEDAR LAKE

PLATE Nº 49



Department of the Interior Canada

[illegible]

[illegible]

[illegible]

[illegible]

PASQUIA RECLAMATION PROJECT

SASKATCHEWAN RIVER

CEDAR LAKE TO CROSS LAKE

TOPOGRAPHIC SHEET Nº 9

[illegible]

[illegible]

[illegible]

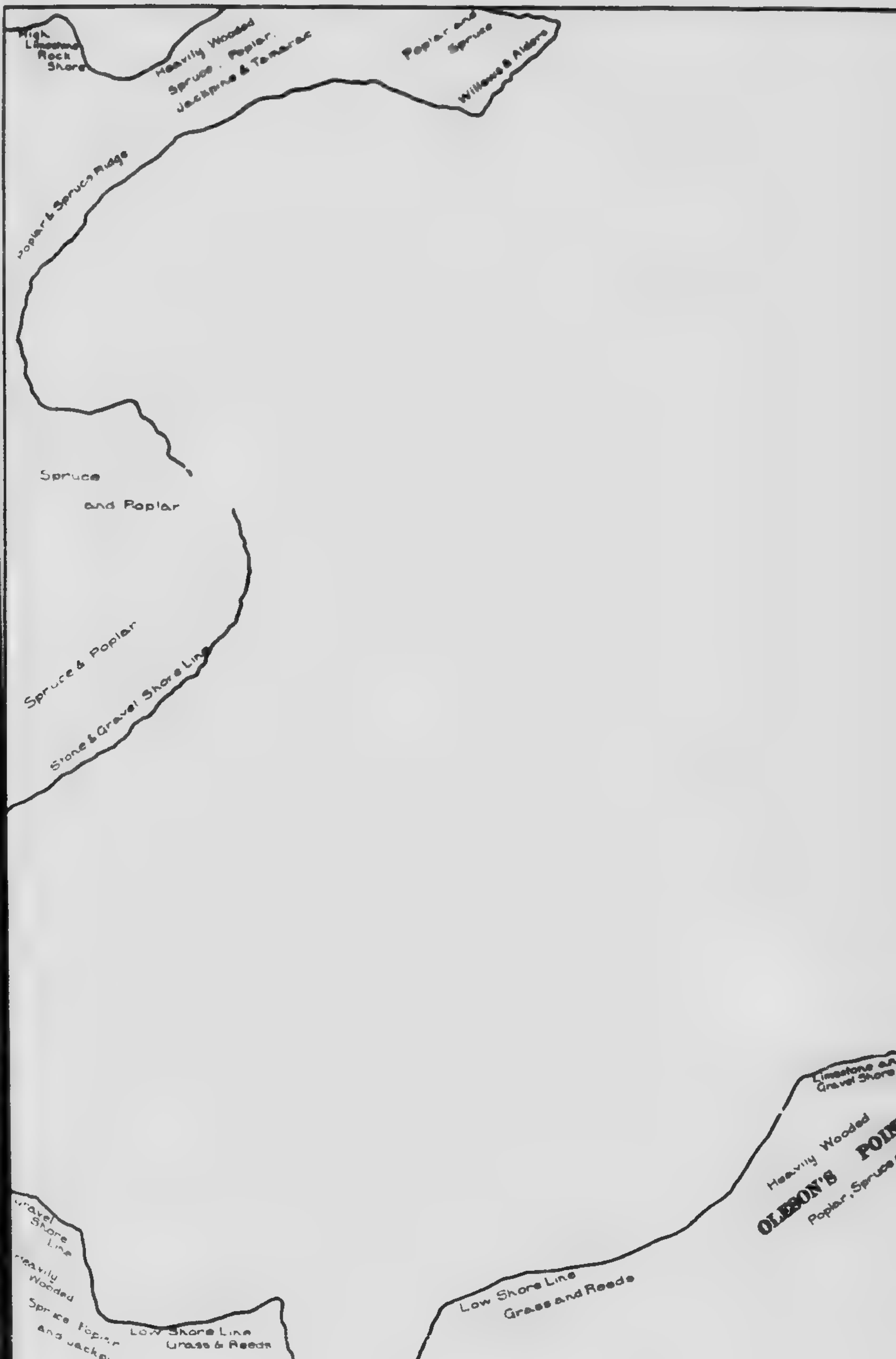

High Limestone Rock Shore
Heavily Wooded
Spruce, Poplar,
Jackpine & Tamarac
Poplar and Spruce
Willows & Alders
Poplar & Spruce Ridge
Spruce
and Poplar
Spruce & Poplar
Stone & Gravel Shore Line
Limestone an
Gravel Shore
Heavily Wooded
OLESON'S POI
Poplar, Spruce
Gravel Shore Line
Heavily Wooded
Spruce Poplar
And Jackpine
Low Shore Line
Grass & Reeds
Low Shore Line
Grass and Reeds

PLATE No 50

Department of the Interior Canada
[illegible]
[illegible]

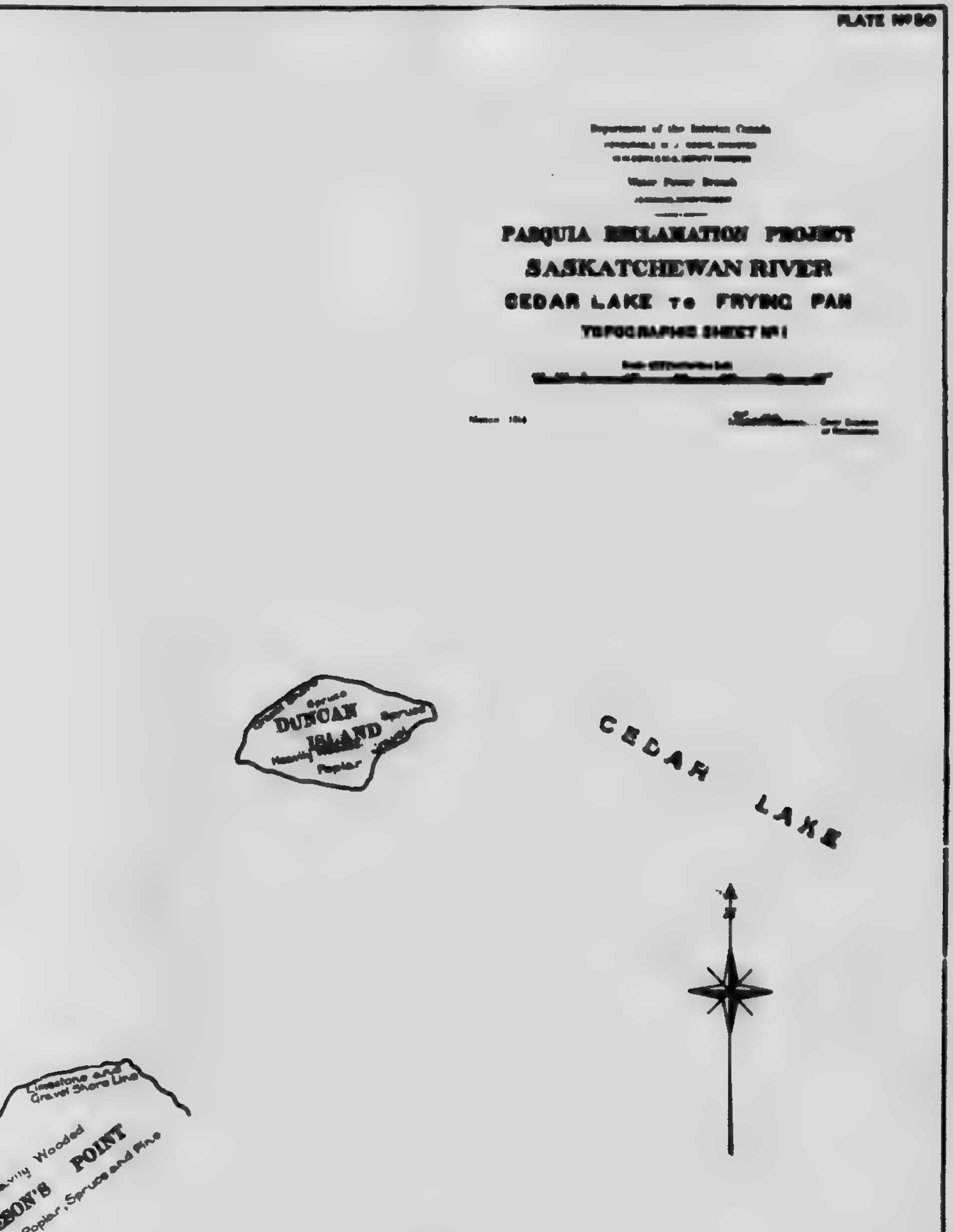
Water Power Branch
[illegible]

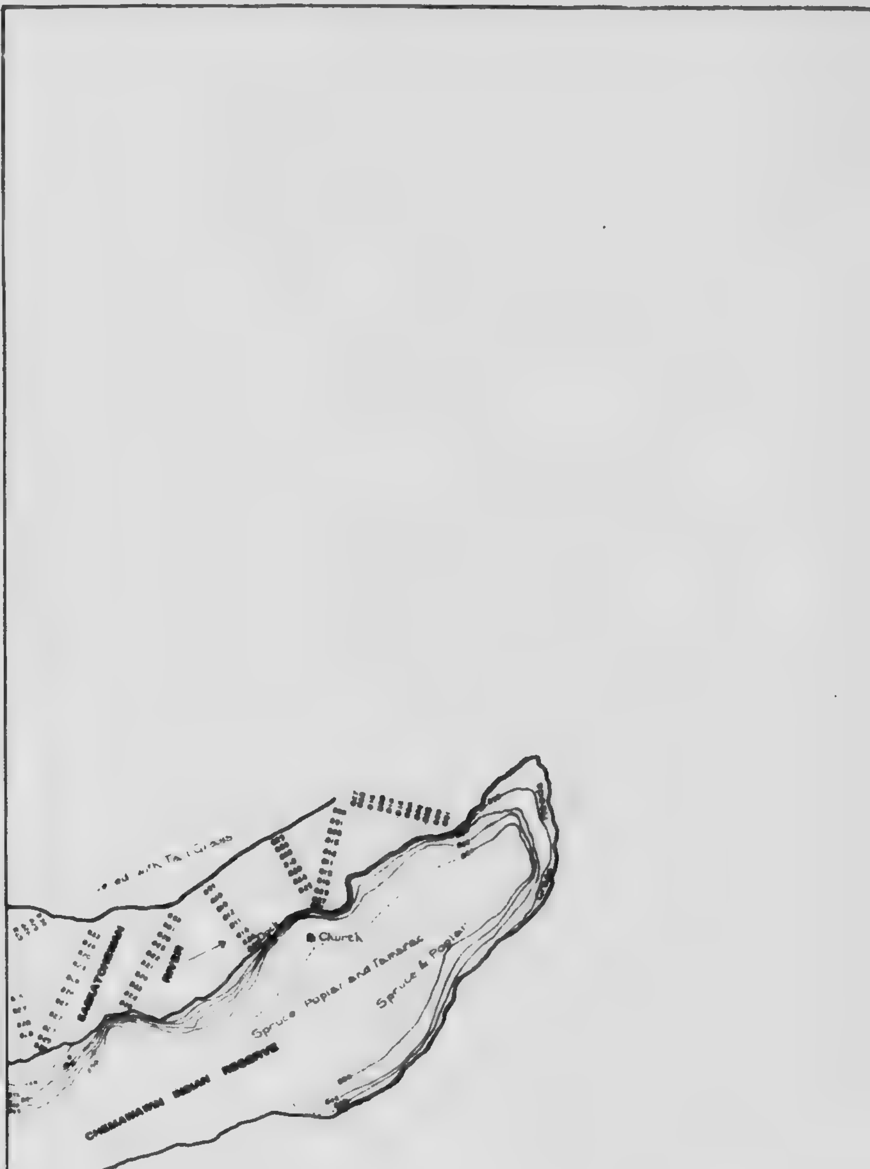
PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO FRYING PAN
TOPOGRAPHIC SHEET No 1

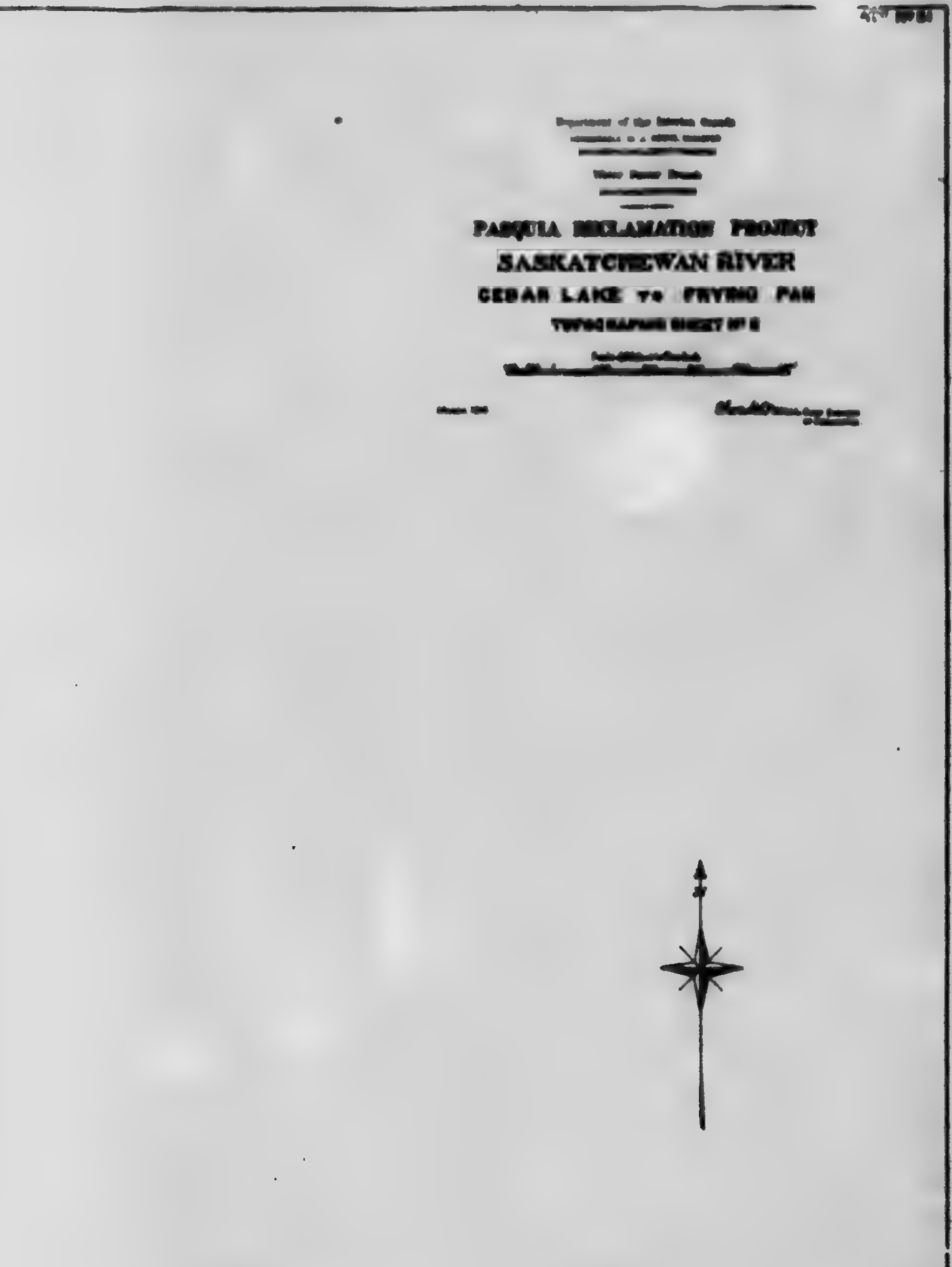
Scale [illegible]

[illegible] 1914

[illegible]




ed with Tall Grass
SASKATCHEWAN
RIVER
Church
Spruce Poplar and Tamarac
Spruce & Poplar
CHEMAWAWIN INDIAN RESERVE
High Limestone Rock Shore
Heavily Wooded
Spruce, Poplar,
Jackpine &
Tamarac
Limestone Rock 12 High
Tall Grass and Reeds



Department of the Interior Canada

[illegible]

Water Power Branch

PASQUIA RECLAMATION PROJECT

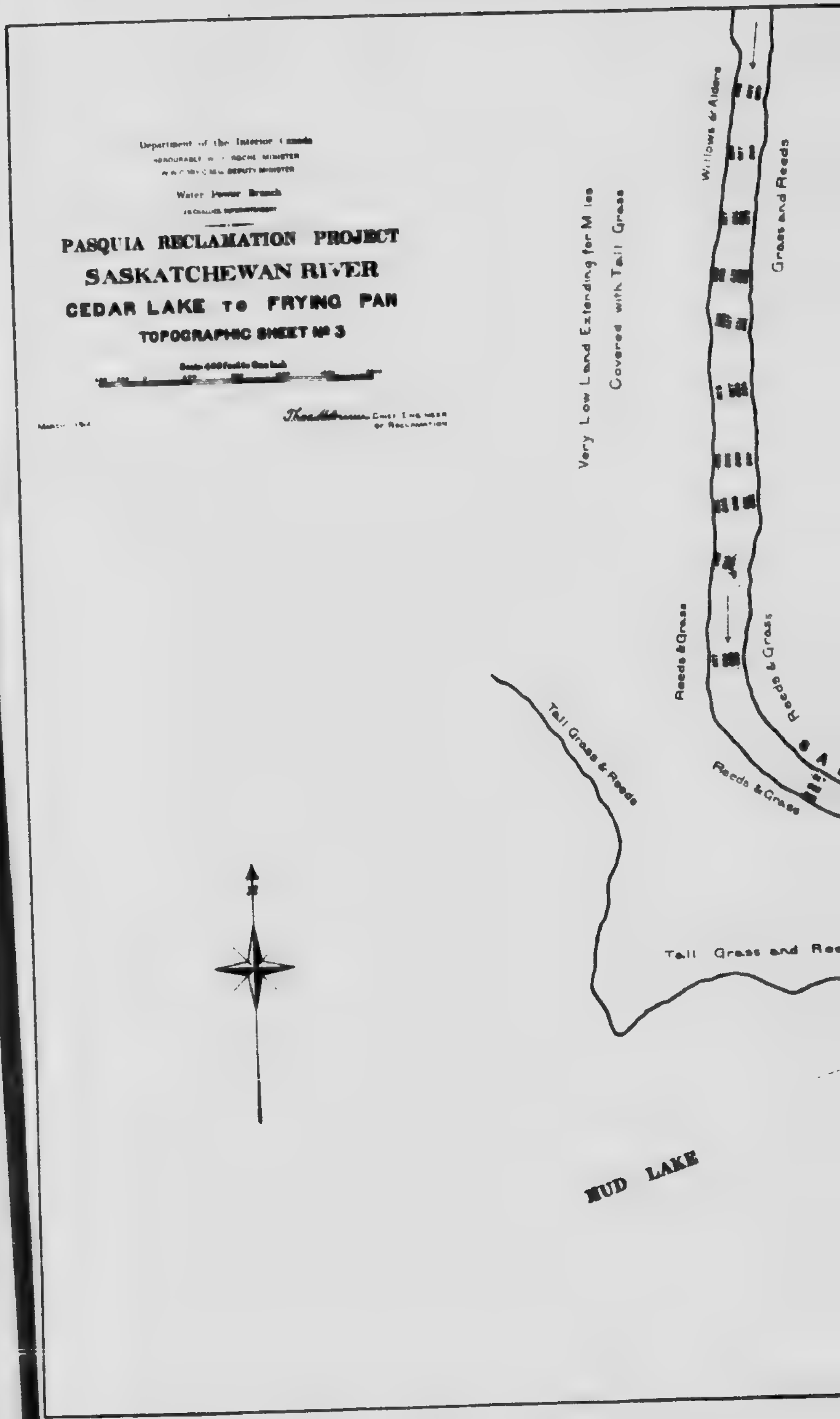
SASKATCHEWAN RIVER

CEDAR LAKE TO FRYING PAN

TOPOGRAPHIC SHEET Nº [illegible]

[illegible]

[illegible]



Department of the Interior Canada
HONOURABLE W. J. ROCHE MINISTER
W. W. CORY C.M.G. DEPUTY MINISTER

Water Power Branch
J. B. CHALLIES SUPERINTENDENT

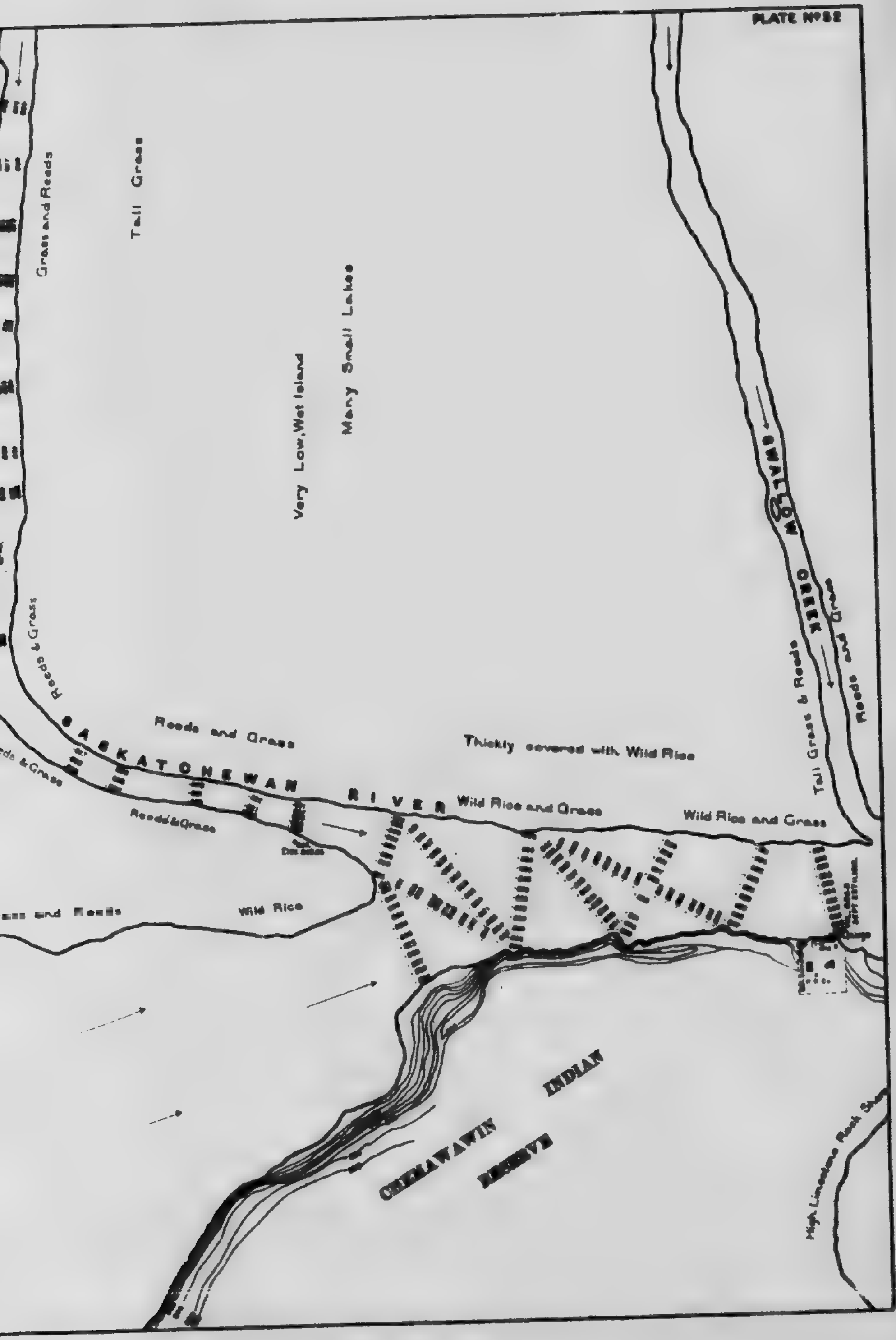
PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO FRYING PAN
TOPOGRAPHIC SHEET № 3

Scale 400 Feet to One Inch

March 1914

CHIEF ENGINEER OF RECLAMATION

PLATE No 32


Grass and Reeds
Tall Grass
Very Low, Wet Island
Many Small Lakes
SMALL
CREEK
Reeds & Grass
Reeds and Grass
Thickly covered with Wild Rice
Tall Grass & Reeds
Reeds and Grass
SASKATCHEWAN RIVER
Wild Rice and Grass
Wild Rice and Grass
eds & Grass
Reeds & Grass
ass and Reeds
Wild Rice
INDIAN
CHEMAWAWIN
RESERVE
High Limestone Rock Sho

Department of the Interior, Canada
Honourable W. J. Roche, Minister
W. W. Cory, C.M.G., Deputy Minister

Water Power Branch
J. B. Challies, Superintendent

PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO FRYING PAN
TOPOGRAPHIC SHEET Nº 4

[illegible]
[illegible]

March 1914

Chief Engineer of Reclamation.

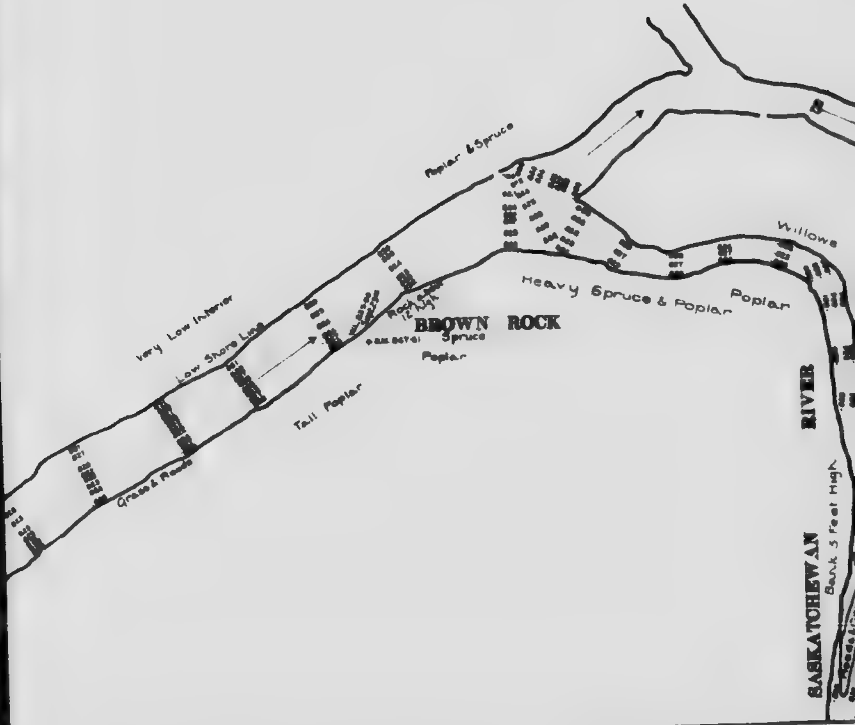
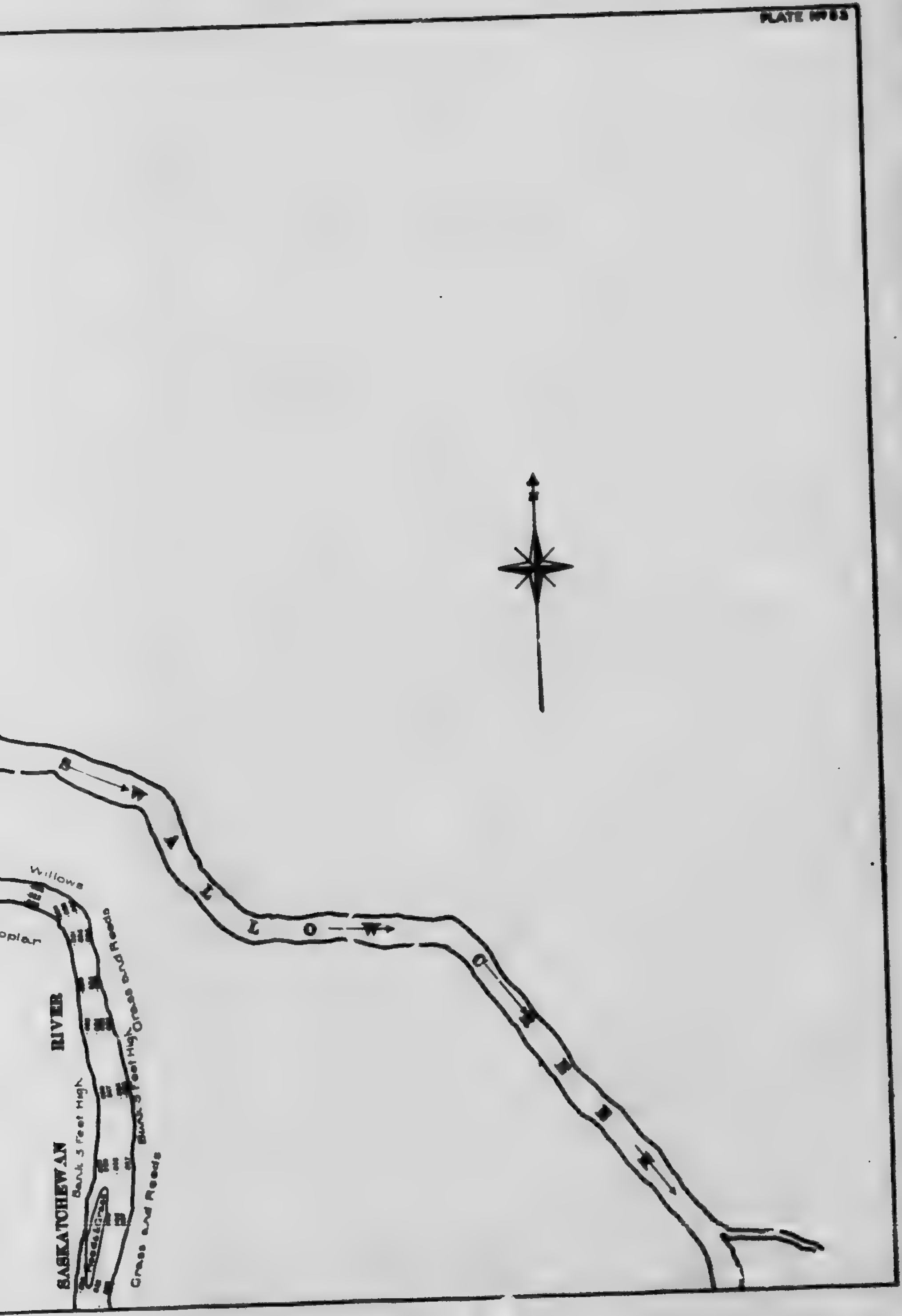
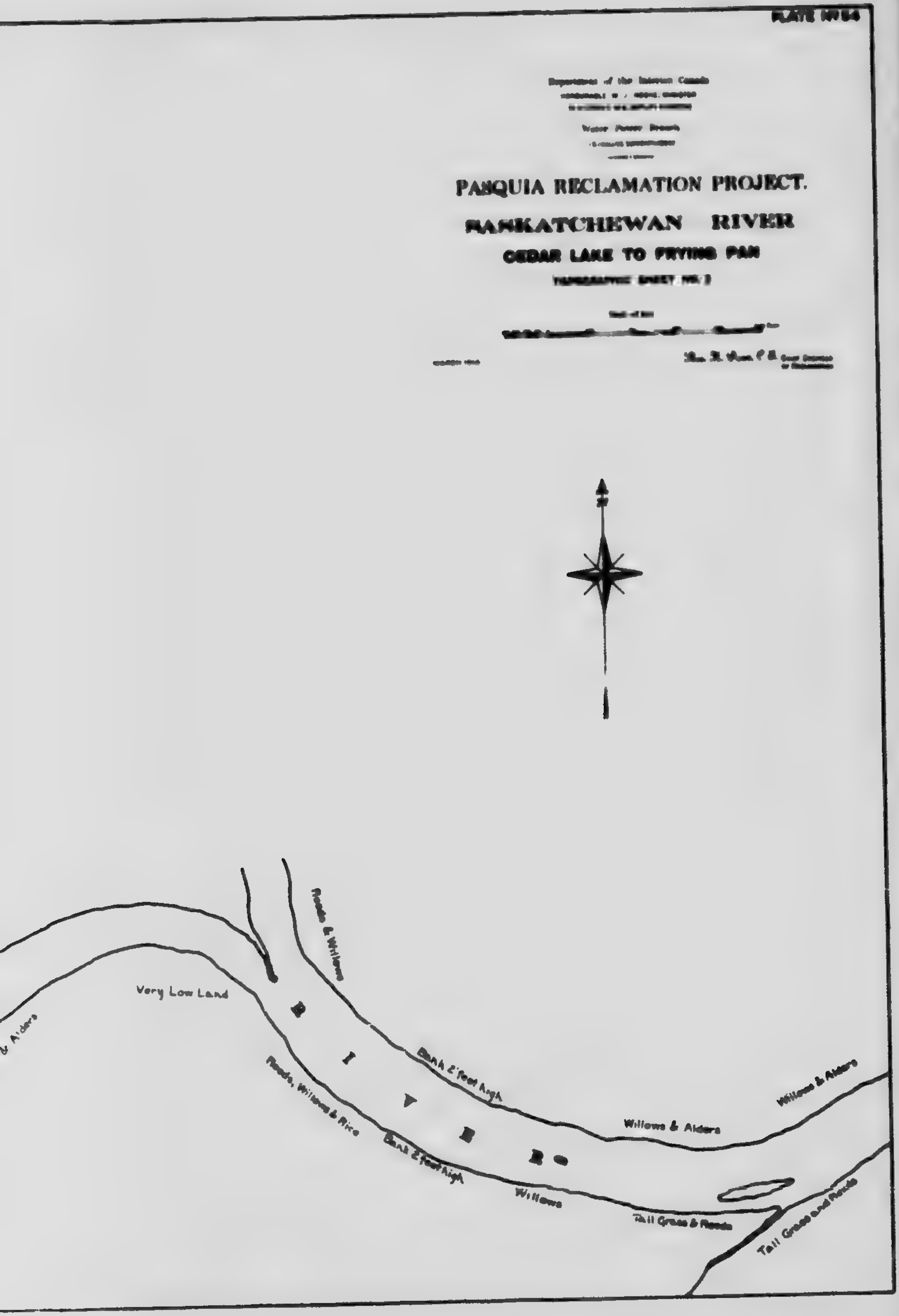


PLATE No 63



N
S
W
A
L
L
O
W
O
Willows
oplar
RIVER
SASKATCHEWAN
Bank 3 Feet High
Bank 3 Feet High
Grass and Reeds
Grass and Reeds
Reeds & Grass

SASKATCHEWAN
Tall Grass & Wild Rice
Willows & Alders
Willows & Alders
Very Low Wet Land


[illegible]
Department of the Interior Canada
[illegible]
Water Power Branch
[illegible]
PASQUIA RECLAMATION PROJECT.
SASKATCHEWAN RIVER
CEDAR LAKE TO FRYING PAN
[illegible]
N
Reeds & Willows
Very Low Land
& Alders
R I V E R
Bank 2 feet high
Reeds, Willows & Rice
Bank 2 feet high
Willows
Willows & Alders
Willows & Alders
Tall Grass & Reeds
Tall Grass and Reeds

Department of the Interior Canada
HONOURABLE W. J. ROCHE MINISTER
W. W. CORY C.M.G. DEPUTY MINISTER

Water Power Branch
J. B. CHALLIES SUPERINTENDENT

PASQUIA RECLAMATION PROJECT.

SASKATCHEWAN RIVER

CEDAR LAKE TO FRYING PAN

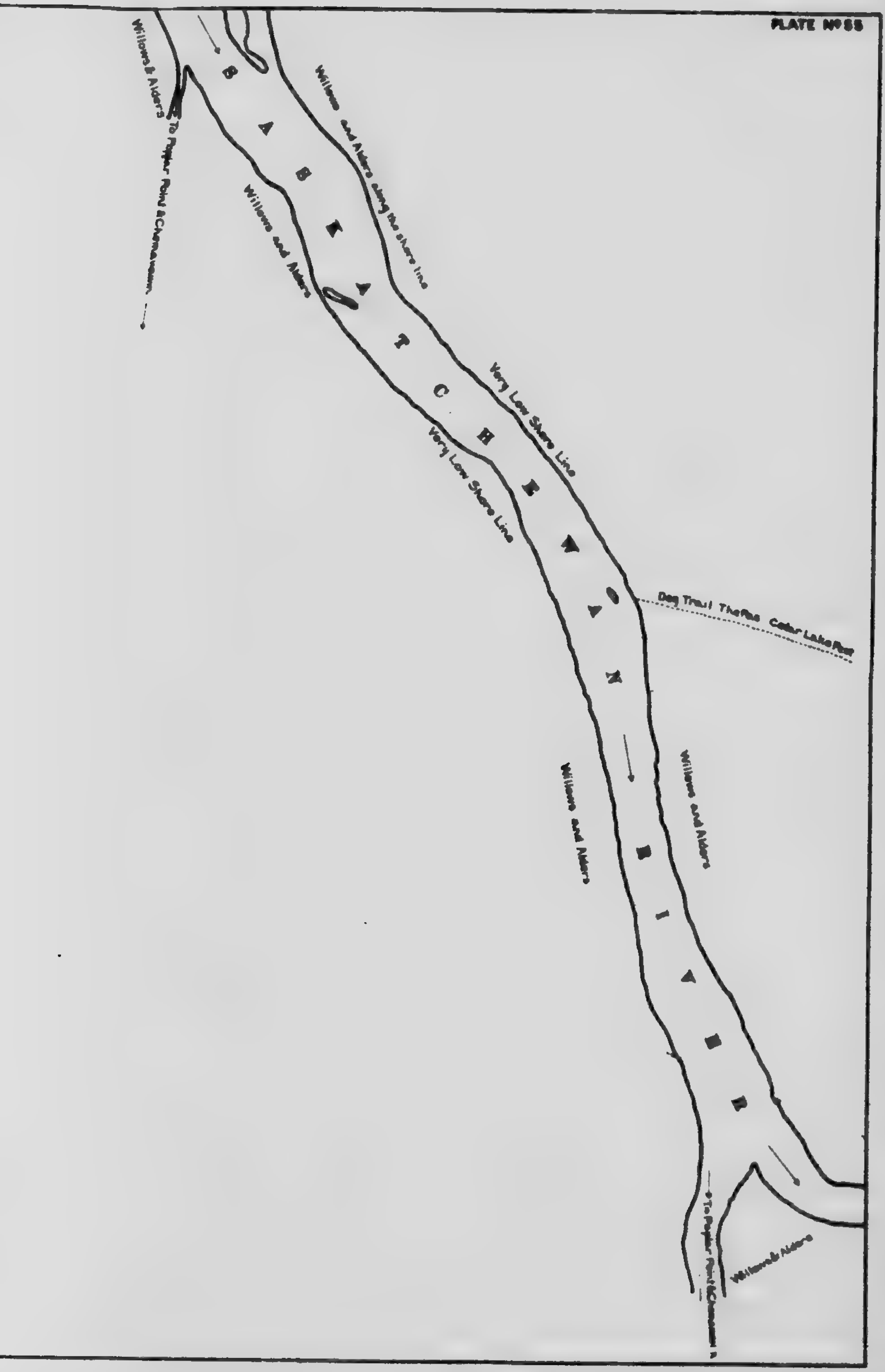
TOPOGRAPHIC SHEET NO 6

Scale of feet

[illegible]

[illegible] Chief Engineer [illegible]

PLATE No 55


SASKATCHEWAN RIVER
Willows & Alders
To Poplar Point & Chemawawin
Willows and Alders along the shore line
Willows and Alders
Very Low Shore Line
Very Low Shore Line
Dog Trail The Pas Cedar Lake Post
Willows and Alders
Willows and Alders
To Poplar Point & Chemawawin
Willows & Alders

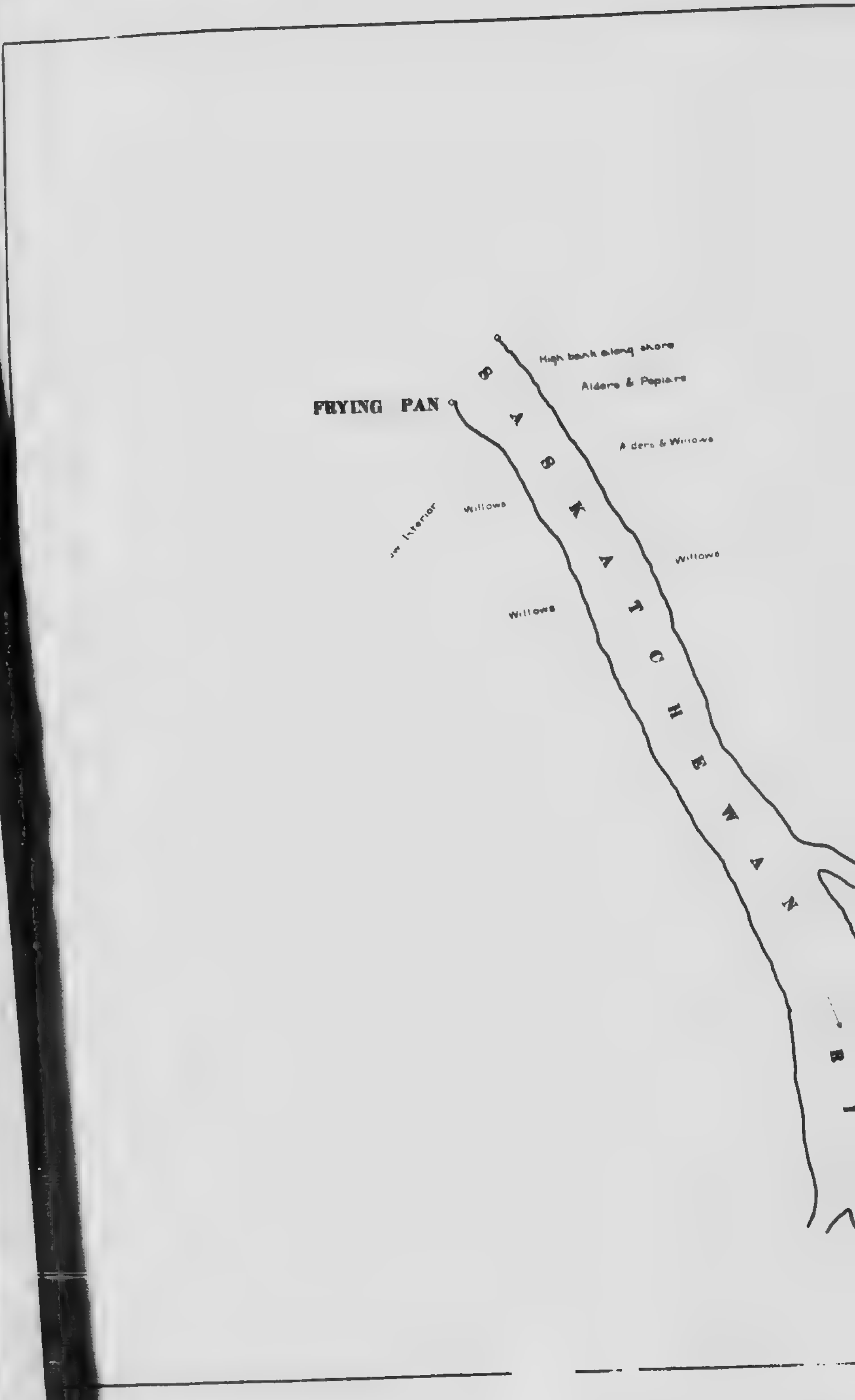
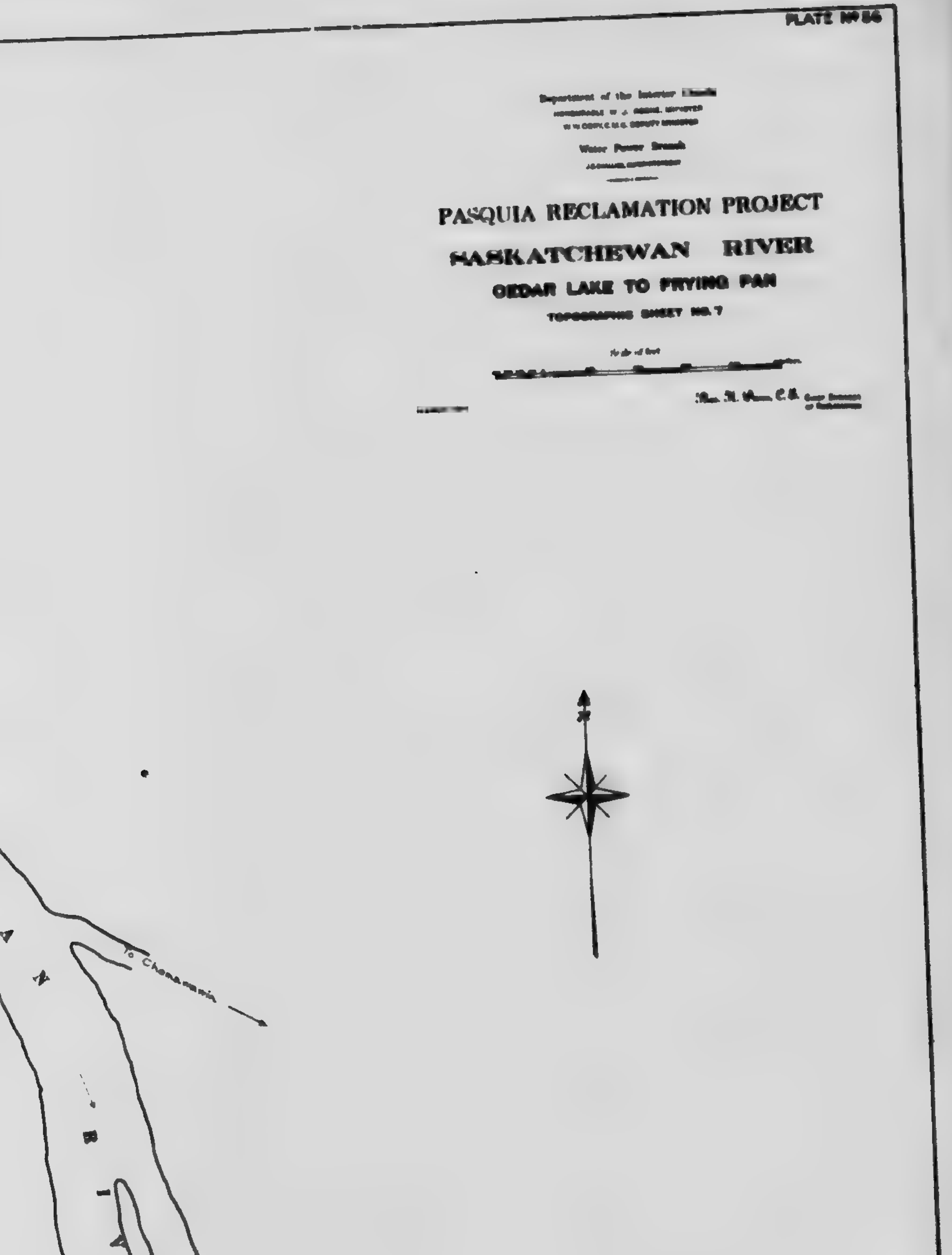

FRYING PAN
SASKATCHEWAN
High bank along shore
Alders & Poplars
Alders & Willows
ow Interior
Willows
Willows
Willows
R

PLATE Nº 56



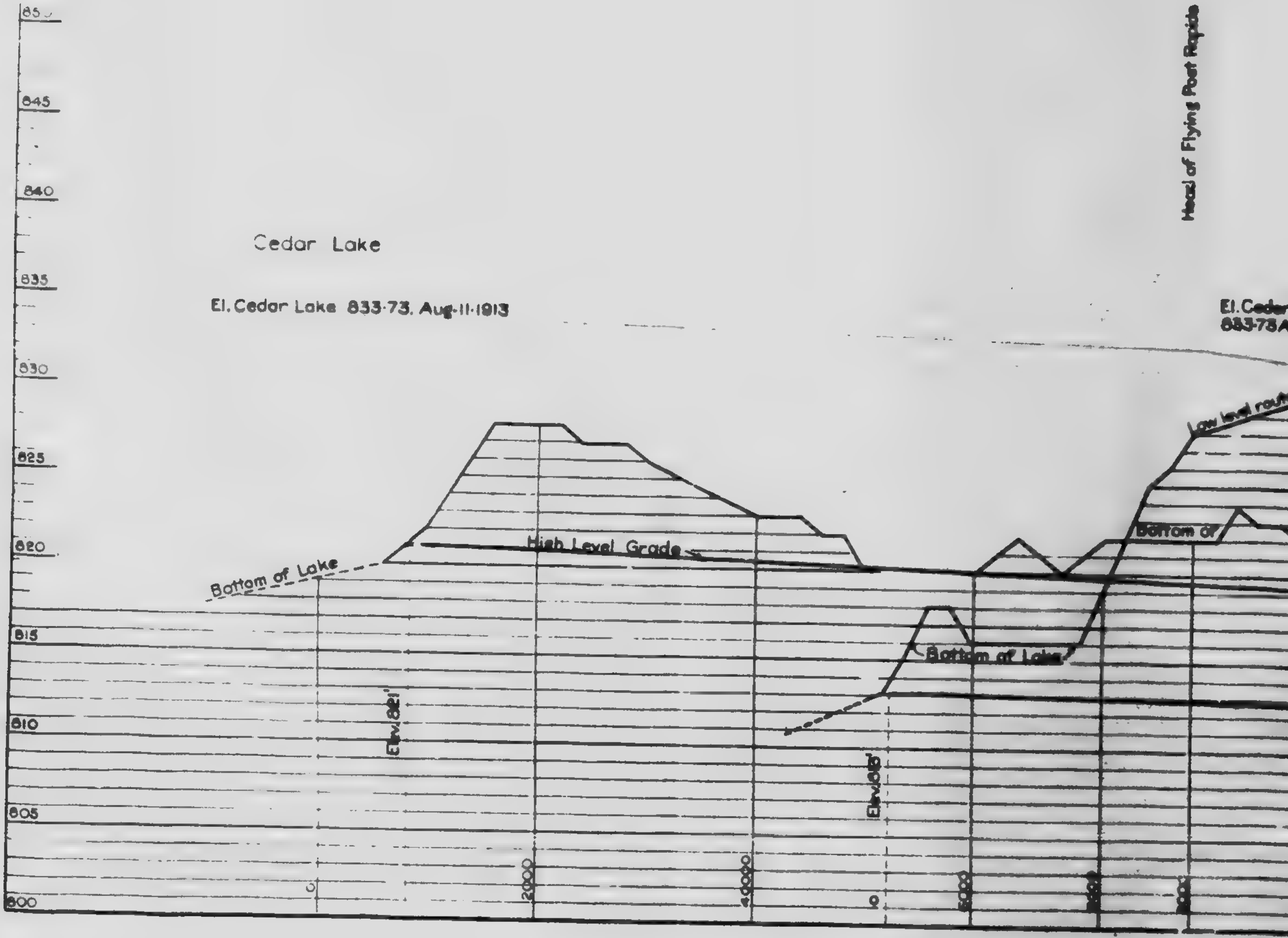
Department of the Interior Canada
HONOURABLE W. J. ROCHE, MINISTER
W. W. CORY, C.M.G. DEPUTY MINISTER

Water Power Branch
J. B. CHALLIES, SUPERINTENDENT

PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
CEDAR LAKE TO FRYING PAN
TOPOGRAPHIC SHEET NO. 7

Scale of feet

[illegible] C.E. [illegible]


850
845
840
835
830
825
820
815
810
805
800
Cedar Lake
El. Cedar Lake 833·73. Aug·11·1913
Head of Flying Post Rapids
El. Cedar
833·73 A
Low level rout
High Level Grade
Bottom of Lake
Bottom of Lake
Bottom of
Elev. 821'
Elev. 812'
0
2000
4000
0

Department of the Interior, Canada
HONOURABLE W. J. ROCHE, MINISTER
W. W. CORY, C.M.G. DEPUTY MINISTER

Water Power Branch
J. B. CHALLIES, SUPERINTENDENT

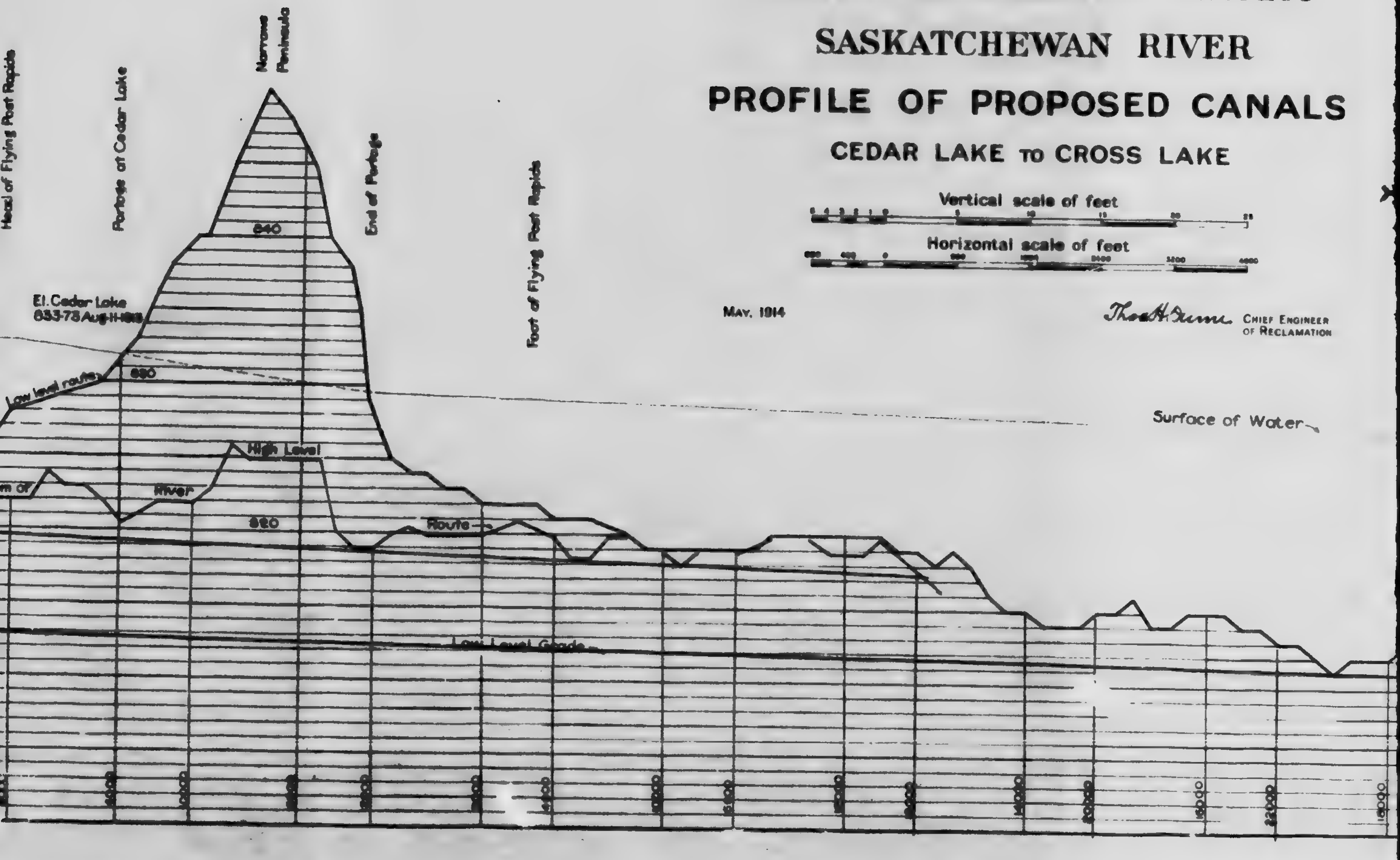
PASQUIA RECLAMATION PROJECT
SASKATCHEWAN RIVER
PROFILE OF PROPOSED CANALS
CEDAR LAKE TO CROSS LAKE

Vertical scale of feet

Horizontal scale of feet

MAY, 1914

Thos H. Fume CHIEF ENGINEER OF RECLAMATION



Department of the Interior, Canada
HONOURABLE W. J. ROCHE, MINISTER
W. W. CORY, C.M.G. DEPUTY MINISTER

Water Power Branch
J. B. CHALLIES, SUPERINTENDENT

PASQUIA RECLAMATION PROJECT

SASKATCHEWAN RIVER

PROFILE OF PROPOSED CANALS

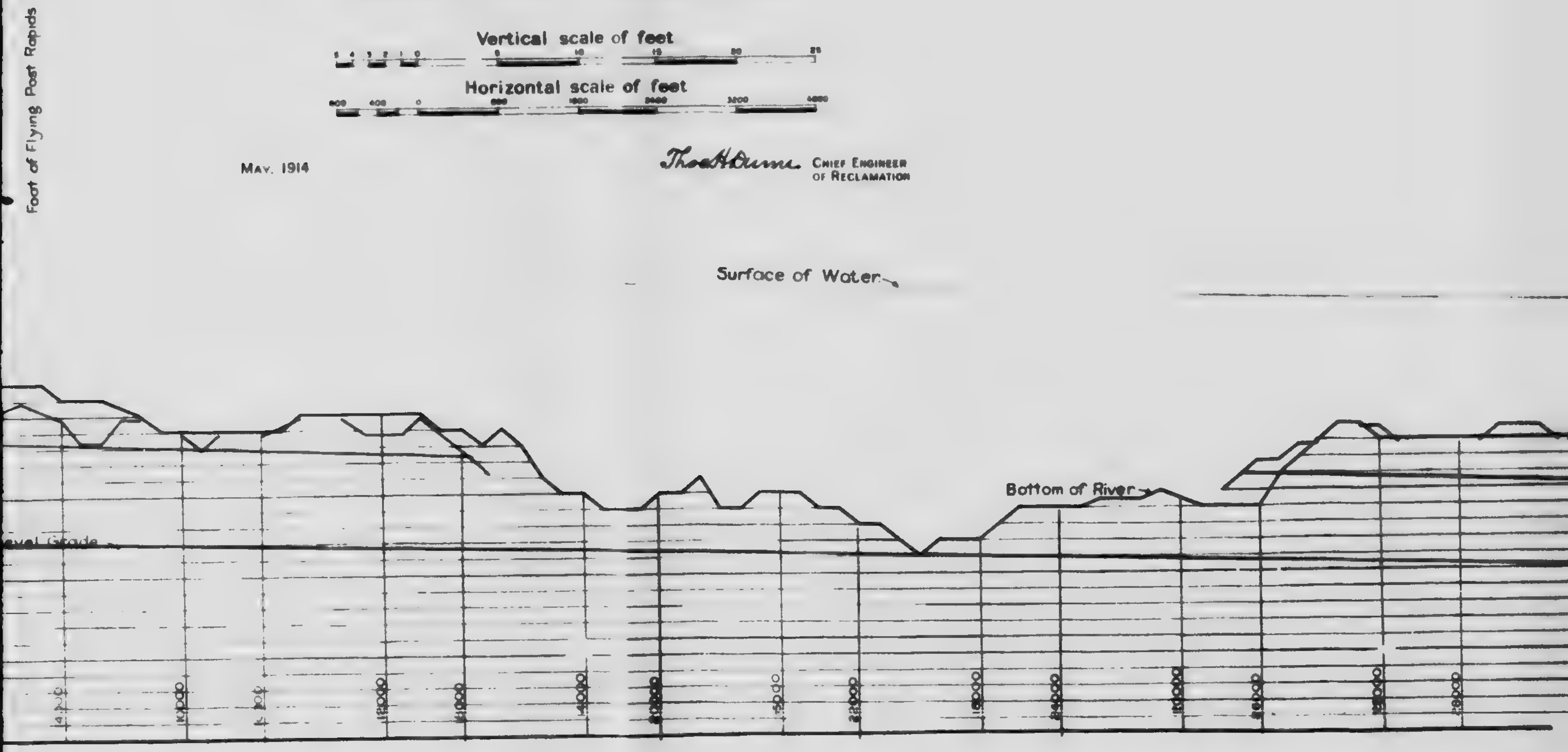
CEDAR LAKE TO CROSS LAKE

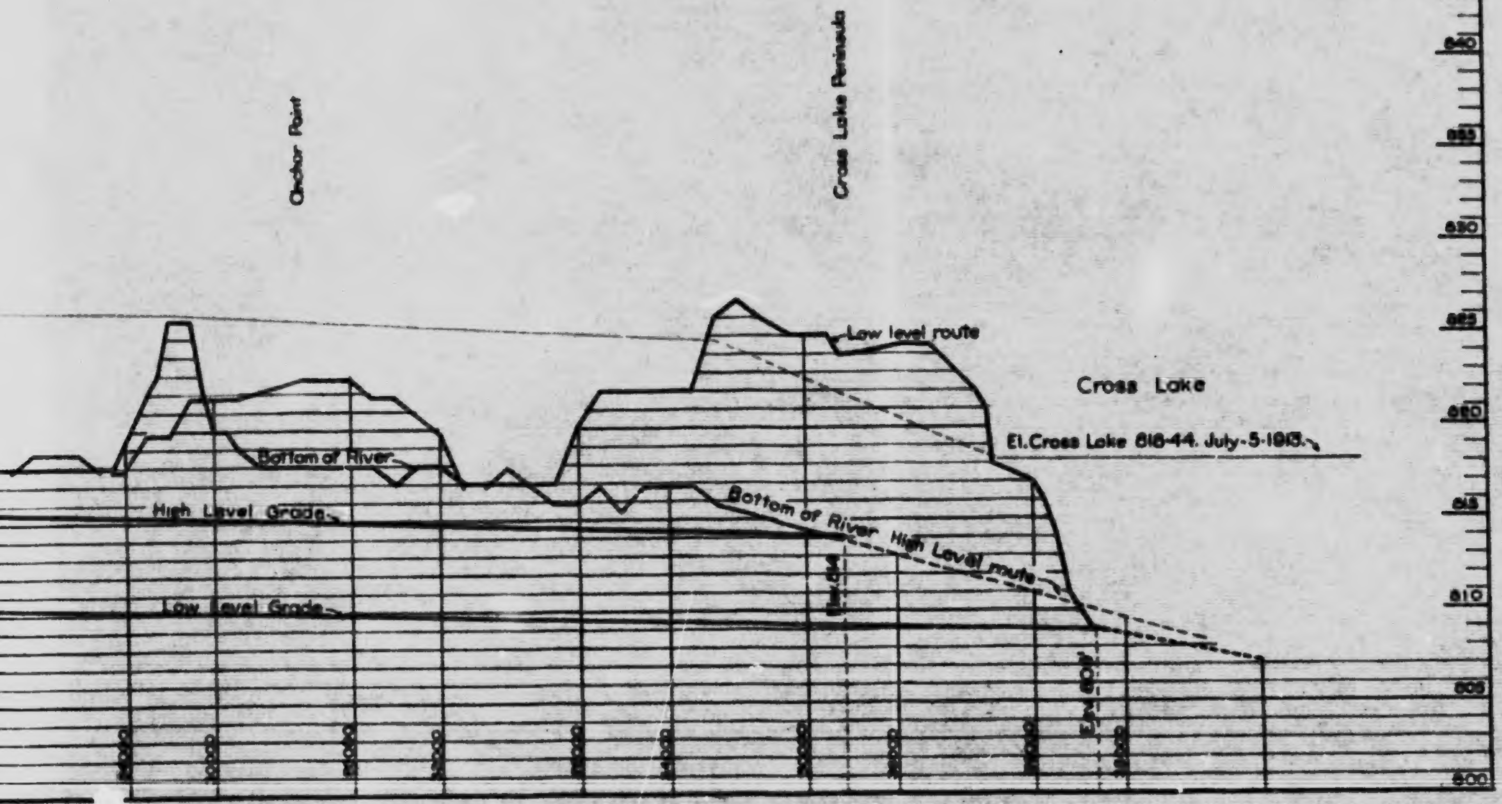
Vertical scale of feet
5 4 3 2 1 0 5 10 15 20 25

Horizontal scale of feet
800 400 0 800 1600 2400 3200 4000

MAY, 1914

Thos H Dunne CHIEF ENGINEER OF RECLAMATION




Anchor Point
Cross Lake Peninsula
Low level route
Cross Lake
El. Cross Lake 818-44. July-5-1913.
Bottom of River
High Level Grade
Bottom of River High Level route
Low Level Grade
El. 808'
850
845
840
835
830
825
820
815
810
805
800